SUGAR BEET RESEARCH
1959 REPORT

Compiled by Sugar Beet Section

CROPS RESEARCH DIVISION
AGRICULTURAL RESEARCH SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE

CR-4-60

United States Department of Agriculture
Agricultural Research Service
Crops Research Division
Beltsville, Maryland

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1959 REPORT[1]

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[1] This is a progress report of cooperative investigations containing data, the interpretation of which may be modified with additional experimentation. Therefore, publication, display, or distribution of any data or statements herein should not be made without prior written approval of the Crops Research Division, A.R.S., U. S. Department of Agriculture, and the cooperating agency or agencies concerned.

CR-4-60

FOREWORD

Sugar Beet Research is issued annually by the Sugar Beet Section as a compilation of current reports presented by staff members and cooperators. The Report serves primarily as a medium of presenting investigations that have been strengthened by contributions from the Beet Sugar Development Foundation and as a means of reporting research accomplishments under Cooperative Agreements between Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, and the Beet Sugar Development Foundation; the Farmers & Manufacturers Beet Sugar Association; and the Union Sugar Division, Consolidated Foods Corporation.

Some of the investigations presented by staff members of the Sugar Beet Section, as well as by Cooperators, have not been supported by the Beet Sugar Development Foundation. The reports and results of field tests from various sources have been arranged in "Parts" of the Report according to subject matter; consequently, the separate Parts of the Report are not restricted to areas of investigations outlined specifically by Foundation projects. However, the relevant Foundation project has been indicated on the title page of each Part.

Cooperative field tests conducted by State Agricultural Experiment Stations, the Farmers & Manufacturers Beet Sugar Association, and Agricultural Departments of Sugar Companies, have added greatly to the information concerning variety performances. The cooperation, as it applies, has been indicated under the various Parts of this Report.

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HIGHLIGHTS OF ACCOMPLISHMENTS[1]

New Inbreds, Varieties, and Hybrids.--During 1959, the Sugar Beet Section made available to the Beet Sugar Development Foundation 17 new developments in breeding research for seed increase under provisions of a Memorandum of Understanding. The items proposed for seed increase and utilization have been described on pages 7 to 11. The acceptance of the various items by the Foundation and plan of utilization by company members have been given on pages 12 and 13. Small quantities of seed of most of the items being increased were supplied to members of the Foundation, thereby permitting the company breeders to explore the potential value of the items in their breeding programs while seed increases are being made. Some of the items that are not being increased through the Foundation have also been supplied to company members for use in their breeding programs.

Seed productions in 1959 of items proposed for seed increase in 1958 are given on pages 14 and 15. The description of these items proposed for seed increase and utilization in 1958 is given on pages 7 to 12 in the 1958 Report.

Plant breeders of sugar companies have requested, through the Beet Sugar Development Foundation, genetic strains and special items of breeding material developed by the staff of the Sugar Beet Section. In response to requests in 1959, staff members of the Sugar Beet Section supplied 27 genetic strains and special items of breeding material to company members of the Foundation for use in breeding work.

Breeding for Curly Top Resistance and for Quality Improvement.--In the 1958 Report, the combining ability and high curly top resistance of CT5 was discussed. This line has been used in the production of several hybrids included in tests conducted at Jerome, Idaho, by A. M. Murphy, and at Taylorsville, Utah, by C. H. Smith. Special mention will be made of the 3-way monogerm hybrid, SL 8111, in which CT5 occurred as a parent. CT5 was crossed with CT9. The F_1 was then used as the pollinator with the male-sterile monogerm line 531H60, giving the 3-way combination of 531H60MS X (CT5aa X CT9). This 3-way hybrid was the entry highest in sucrose percentage and acre yield of roots and gross sugar in the test at Taylorsville and gave good performance in the test at Jerome, where curly top was severe. In addition to its field performances, SL 8111 is of interest as an illustration of the manner in which both cytoplasmic and Mendelian male sterility can be employed in the production of multiple hybrids. The F_1 (CT5 X CT9) has been used as pollinator in a mating with US 22MS, and the resultant multigerm hybrid, SL 8104, gave excellent performances under curly top exposure at Jerome.

The field test conducted at Brawley, Calif., by K. D. Beatty gave evaluations of varietal performances 5 months or more in advance of tests in the Intermountain area. In the two tests planted in September 1958 and harvested in April 1959, the 13 hybrids obtained by intercrossing monogerm lines were inferior to hybrids in which one or both parents were multigerm. This advanced information on hybrid performances enables the investigator to more effectively plan the use of breeding material.

[1] By Dewey Stewart

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Studies reported by Owen and Ryser indicate that subline US 201-20 has performed as a homozygous pollen restorer when used as pollinator with plants in which cytoplasmic factors influence pollen suppression. However, pollen production in the F_1 plants is strikingly influenced by nutrition and environment. It is also pointed out that the factors for pollen restoration carried by US 201-20 are not of equal potency when reacting with cytoplasmic factors for pollen suppression from different sources.

The variety evaluations at Jerome, Idaho, were conducted on two levels of nitrogen fertilization. The entries in tests 1A, 1B, and 1C were the same at each level. In each experiment, the mean acre yield of roots was increased by the additional nitrogen that was applied in mid-July. In each experiment, however, the additional application resulted in a reduction of about one percentage point for sucrose and more than two percentage points for purity. The apparent gain from nitrogen application, as expressed in root yield, was largely offset by the reduction in quality. Experiment 1C showed an actual reduction in calculated gross sugar for the nitrogen application. In the three experiments, each entry responded to the high level of nitrogen fertilization by increased root yield and by reduced quality of the roots.

Nitrate distribution in the soil profile has been studied by Myron Stout as a factor determining quality in the sugar beet crop. It has been shown that height of bed and depth of irrigation furrow, as well as irrigation practices and rainfall, may be important factors in making nitrates available to the plant, thereby influencing quality of roots at harvest.

Interspecific Hybrids.--The wealth of breeding material produced by Helen Savitsky from crossings of the cultivated forms of beet and species comprising the section Patellares of the genus Beta was given in 1958 Report. In 1959, efforts were concentrated on production of triploid hybrids through the hybridization of tetraploid sugar beets and tetraploid Swiss chard with the diploid species, B. procumbens and B. webbiana. These triploids were low in viability, and only 30 seedlings out of a total of 308 have survived and developed on their own roots. Plant survival of the triploid hybrids is far below the survival of the diploid and tetraploid interspecific hybrids obtained in 1958. The diploid hybrids were almost completely sterile. A population of approximately 70 F_1 plants produced only 8 seeds--6 on 1 plant and 2 on another. In contrast, the triploid and tetraploid interspecific hybrids were semi-fertile and produced 15 to several hundred seeds per plant. Seeds obtained from the F_1 plants show promise of some degree of self fertility in subsequent generations. These results indicate that polyploidy may be the means of obtaining fertile hybrids of B. vulgaris and species of the section Patellares which are sterile on the diploid level.

Polyploidy in Relation to Sucrose Percentage and Root Yield.--The extensive breeding material tetraploidized by Helen Savitsky has been subjected to critical field experimentation by V. F. Savitsky. Monogerm strains established on the tetraploid level did not differ from their parental diploid strain in either percentage sucrose or root weight. It has been shown that heterosis for root yield occurs in both the tetraploid and the diploid

hybrid. The sucrose percentage in the tetraploid F_1 was close to the mean percent of the two parents. In a test in which a diploid hybrid could be compared with a triploid hybrid and a tetraploid hybrid--all involving the same ancestral strains--the diploid F_1 was lowest in root yield and the triploid was highest in sugar per root. For the strains involved, it is thought that the triploid level gives the most favorable expression of the polygenic balance for sucrose percent and root weight.

Breeding for Nematode Resistance.--In screening tests conducted by Charles Price to determine the resistance of sugar beets to the nematode, seedlings are transplanted to greenhouse flats of sterilized compost that has been contaminated with a small quantity of field soil containing approximately 200 nematode cysts per gram as well as other pathogens--presumably fungi. Seedlings of some nematode tolerant strains have shown a striking ability to survive under exposure to this virulent inoculum (fig. 1, p. 78).

In a test conducted by C. H. Smith in a field heavily infested with the sugar beet nematode, there was a severe loss of seedlings of many lines. Other lines with high plant survival showed a tendency to foliage wilt in the afternoon, which was taken as an indication of nematode effect. The lines with highest plant survival, least wilting, and largest roots of good shape were considered the most tolerant to the nematode. Individuals for breeding were selected on this basis.

Virus Yellows Investigations.--The research of J. E. Duffus has shown that the radish yellows virus is capable of inducing yellowing in the sugar beet and that the yellowing symptom is indistinguishable from yellowing caused by isolates of the beet yellows virus. Studies have indicated that the radish yellows virus in sugar beet plantings in California and Oregon is widespread and may be more prevalent in these areas than the beet yellows virus. In a field test conducted at Salinas, California, sugar beets inoculated with isolates of radish yellows virus showed a reduction in root yield and sucrose percentage of about the same magnitude as plants inoculated with sugar beet yellows virus. Sugar beet plants inoculated with both viruses showed a drastic reduction in root yield which was approximately equal to the total reduction when the two viruses were used separately.

Progress has been made by J. M. Fife in the development of greenhouse and laboratory techniques that facilitate a study of the influence of virus yellows on the concentration of the amino acids in the sugar beet. Mature leaves of sugar beets showing chronic symptoms of virus yellows had an amino acid pattern which differed from the pattern of mature leaves of healthy plants (p. 103). The amino acid ratio in yellows infected plants was found to vary significantly among individual plants within strains. Diseased plants which had amino acid ratios greater than the mean of the population by at least twice the standard deviation were selected for seed production. This method of selection for possible resistance to virus yellows will be compared with selections made on the basis of root size.

Development of Productive Hybrids.--The new hybrids (US H2, US H3, US H4, US H5A, and US H5B), which were developed by J. S. McFarlane, have given excellent performances in California. In some districts, US H2 has been

outstanding. In the Imperial Valley, the gross sugar yield of US H2 was 20 percent above that of US 75 as an average for a 3-year period (1957-1959). The hybrid has performed almost as well in other beet-growing districts of the State. It is worthy to note that the new hybrids have been consistently higher than US 75 in sucrose percent.

The basic parental lines of these hybrids are NB1, a male-sterile line, and certain type "O" lines. The male-sterile of NB1 is crossed with the type "O" lines to produce male-sterile F_1's. In the production of commercial seed of each of these new hybrids, a male-sterile F_1, which is used as the principal seed bearer, is mated to a complementary pollinator to give a 3-way cross.

Progress has been made by J. S. McFarlane in the breeding of monogerm hybrids. Although these hybrids are not as productive as US H2 in relation to US 75, they represent a distinct accomplishment.

Breeding Procedures and Special Techniques.--Experiments have been continued by I. O. Skoyen at Salinas and by Powers and Hecker at Fort Collins to explore the potential use of the gametocide, FW 450, in hybrid seed production. The results of their investigations in 1959 confirm previous reports that the chemical will suppress pollen production in the sugar beet but that rates of treatment which are effective in suppressing pollen production also adversely affect seed yield and germination. The results indicate that FW 450, if applied timely and in proper concentrations, will suppress pollen production in the sugar beet; but its use as a tool in commercial hybrid seed production will require additional experimental work.

Studies on methods of Rhizoctonia inoculation that might be used in resistance breeding have been continued by J. O. Gaskill. A new method, in which the inoculum is applied to the center of the foliar rosette rather than to the root, appears to be more practicable and equally as effective as methods previously devised.

A screening test for black root resistance, developed by C. L. Schneider, makes possible the detection of susceptible sorts and thereby reduces the expense of field evaluation. The results of screening tests to determine the black root resistance of a large number of accessions of culinary beets indicate only a few as resistant as US 401 and none significantly more resistant.

Breeding conducted by G. E. Coe for the improvement of monogerm sugar beets has shown continuous progress with respect to leaf spot and black root resistance. The new synthetic varieties developed in this breeding program are showing increased vigor and root yield.

Population Genetics and Breeding.--Using a procedure of selecting against the mean of small units in a planting of a commercial variety, 32 plants out of a potential population of over 11,000 were chosen by certain criteria of evaluation for polycross test. Ten plants which were superior on the basis of the polycross test were interplanted as clones for seed production. In tests reported by Powers and Hecker, the synthetic variety showed improvement over the parental variety in both percentage sucrose and weight

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per root. In percentage sucrose and sugar per root, the odds were greater than 19:1, in favor of the synthetic, against these differences being chance deviations from the performance of the parental variety.

Two tetraploid lines were compared with their diploid inbred parent in tests reported by Powers and Hecker. Each of three tetraploid sublines of one inbred, when compared with the diploid parent, was higher in root weight and lower in percentage sucrose. Tetraploidization of the other inbred line showed the reverse effect for root weight and percentage sucrose.

Evaluation of Varieties Suitable for the Great Lakes Region.--Extensive cooperative field tests in the Great Lakes Region have indicated that certain monogerm hybrids are as productive as US 401. However, in most of these tests, leaf spot and black root were not major factors influencing the growth of the plants, and the lack of disease exposure may have resulted in a more favorable showing for the monogerm hybrids, which would not be duplicated another year. Male-sterile monogerm lines produced at Salt Lake City have been used as the principal seed bearer and a complementary line that is resistant to leaf spot and black root has been used as the pollinator. Breeding work is under way for the development of monogerm hybrids in which both parents will be locally adapted. Some of the multigerm varieties that are being evaluated have shown excellent production and high quality. These new developments may be of value as pollinators.

Experiments with Russian Monogerm Varieties.--In preliminary field tests, two Russian monogerm introductions did not show outstanding performance. Inheritance studies by Owen and Ryser have demonstrated that monogermness in American and in Russian varieties of sugar beets is not conditioned by the same genic components. This finding may have a definite bearing on future breeding and on the ultimate utilization of the Russian monogerm character in this country.

PART I

NEW DEVELOPMENTS IN BREEDING RESEARCH

Inbreds, Hybrids, and Breeder Seed
of Synthetic Varieties

Items Proposed for Seed Increase
June 3, 1959

Distribution and Utilization of Items

Seed Productions of 1958 Items

NEW DEVELOPMENTS IN BREEDING RESEARCH

Items Proposed for Seed Increase
June 3, 1959

Breeder seed, inbred lines, and varieties which have been developed in the breeding research of the Sugar Beet Section are proposed for seed increase through the Beet Sugar Development Foundation. Seed that is not needed for planting overwintering plots will be furnished on request to company members of the Foundation for utilization in their breeding programs. Brief descriptions, current designations, and estimates of seed available August 1 are given for the items.

These new products of breeding research have been developed by the staff of the Sugar Beet Section in cooperation with:

Colorado Agricultural Experiment Station
Michigan Agricultural Experiment Station
Minnesota Agricultural Experiment Station
New Mexico Agricultural Experiment Station
Beet Sugar Development Foundation
Farmers & Manufacturers Beet Sugar Association
Union Sugar Division, Consolidated Foods Corp.

Items Proposed for Seed Increase and Utilization

I. U. S. Sugar Beet Field Station, Salt Lake City, Utah.

Item 1. Tetraploid SLC 91 mm - - - - - - 300 grams

A curly-top-resistant, self-fertile, large-seeded monogerm inbred line. This tetraploid line does not restore pollen in cytoplasmic male-sterile tetraploid sorts.
(Developed by Drs. V. F. and Helen Savitsky)

Item 2. Male-sterile tetraploid SLC 91 mm - - - 300 grams

A cytoplasmic male-sterile equivalent of tetraploid monogerm SLC 91 mm.
(Developed by Drs. V. F. and Helen Savitsky)

Item 3. SLC 129-0 - - - - - - - 200 grams

A diploid monogerm "Type O" inbred derived from SLC 127 and SLC 128. This seed is from a backcross generation with respect to the Mendelian gene conditioning pollen abortion, and 50 percent of the plants are expected to be male sterile.

Item 4. SLC 129 - - - - - - - 200 grams

Same as SLC 129-0, except that seed came from pollinators, so there should be only 25 percent Mendelian male steriles. A moderate degree of curly-top resistance may be expected.

Item 5. SLC 129 MS - - - - - - - 300 grams

A monogerm male sterile from second backcross to SLC 129.

Item 6. CT9A - - - - - - - - 3 pounds

A curly-top-resistant multigerm inbred representing the S_4 generation of the "new" CT9. It may be of primary interest for those desiring a uniform inbred. It is homozygous RR for red hypocotyl color.

II. U. S. Agricultural Research Station, Salinas, California.

Item 7. C9561 - - - - - - - - 1 pound

This is a "Type O" bolting-resistant monogerm inbred from F_2b_1 (NB1 X C8507). This inbred represents the first backcross in a program aimed at the development of the monogerm equivalent of the multigerm line, NB1. Selection was based primarily on plant type and seed-setting ability. Definite information is not available on bolting resistance, curly-top resistance, and combining ability; however, based on the performance of the two parents, it is anticipated that the bolting resistance will be good and the curly-top resistance moderately good. The NB1 parent has shown very good combining ability, and hybrids involving C8507 as a parent have been high in sucrose percentage.

Suggested utilization: (a) small increase of C9561; (b) an additional backcross to C9561HO (See Item 8 of 1959) to produce the male-sterile equivalent of C9561; (c) production of F_1 hybrids using C9561 as pollen parent and the male-sterile of C7515 (See Item 12 of 1957 and WC No.8341) and the male-sterile of C7569 (See Item 8 of 1958) as seed parents.

Item 8. C9561HO - - - - - - - 1 pound

This male-sterile monogerm represents the first backcross to C9561.

Item 9. C9561H1 - - - - - - - 1 pound

This is the F_1 monogerm hybrid, MS of 7515 X C9561. It is expected that this hybrid will possess good bolting resistance, moderate curly-top resistance, and complete male sterility. It is suggested for use as a female monogerm parent in the production of experimental quantities of three-way hybrids.

Item 10. C951* - - - - - - - 100 grams

A "Type O" selection from C366. (Bolting-resistant US 35.)

Item 11. C952* - - - - - - - 100 grams

A "Type O" selection from US 15.

Item 12. C953* - - - - - - - 100 grams

A "Type O" selection from Klein E.

Item 13. C955* - - - - - - - 100 grams

Bolting-resistant, self-sterile monogerm derived from a hybrid between SL 320mm and US 75. This seed lot has not been tested for performance but should be of value as a self-sterile monogerm breeding stock which combines bolting resistance with some curly-top resistance.

*Items 10, 11, 12, and 13 are Breeder Seed made available for use in crossing programs. Seed increase is not required.

III. Breeding for Improvement in Resistance to Leaf Spot and Black Root:

Plant Industry Station, Beltsville, Maryland
Michigan Agricultural Experiment Station, East Lansing, Michigan
Minnesota Agricultural Experiment Station, Southern Substation, Waseca, Minnesota
Colorado Agricultural Experiment Station, Fort Collins, Colorado.

Item 14. SP 5931-0 - - - - - - - **20 pounds**

This monogerm variety is the increase of outstanding progenies of selected plants out of SP 5831-0 (See Item 17 of 1958). The selection of individuals and progenies was made on the basis of improvement in resistance to leaf spot and black root, in root yield, and in sucrose percentage. It is thought that the improvement of SP 5931-0 over SP 5831-0 in these characteristics will be sufficient to justify a seed increase and maintain SP 5931-0 as a separate item.

Item 15. SP 59300-0 - - - - - - - 1 pound

This monogerm variety was obtained through the interpollination of plants selected from the best progenies of 1958 tests at the Plant Industry Station. Seed of outstanding polycross progenies in field tests of 1959 will be pooled to give SP 59300-0. It is expected that SP 59300-0 will show improvement over SP 5931-0.

IV. Breeding to Combine Resistances to Leaf Spot and Curly Top:*

Plant Industry Station, Beltsville, Maryland
U. S. Sugar Beet Field Laboratories
Salt Lake City, Utah, and Twin Falls, Idaho
New Mexico Agricultural Experiment Station,
State College, New Mexico

Item 16. SP 591-0 - - - - - - - **1 pound**

A synthetic multigerm variety stemming from clones carrying resistance to leaf spot and curly top. The original source material has been noted as having black root resistance. The preceding generation, SP 57105-0, was produced from leaf-spot-resistant selections made at the Plant Industry Station by G. E. Coe. The new item, SP 591-0, was produced from curly-top-resistant selections made by J. C. Overpeck at New Mexico Agricultural Experiment Station. The variety is equal to US 401 in leaf spot resistance and its curly top resistance is good. Preliminary field tests have indicated acceptable sucrose percentage for the variety, but the root yield is slightly less than that for US 401.

*For SP 59E5-0, See Item 17, page 11.

Item 17. SP 59E5-0 - - - - - - - 1 pound

This monogerm variety was obtained through the interpollination of selected plants of SP 5832-0. (See Sugar Beet Research, 1958 Report, page 11.) The outstanding plants in a large planting of SP 5832-0 by the Canada and Dominion Sugar Company, Wallaceburg, Ontario, were further evaluated at East Lansing, Michigan, on root size, sucrose percentage, and chemical constituents. Since the mother plants were grown under moderate leaf spot exposure, there was opportunity to select for resistance to this disease.

V. Special Items Maintained by the Sugar Beet Section: (Not developed in breeding research by the staff.)

Item A. SP 591103-0 - - - - - - - 200 grams

This is an increase, by J. O. Gaskill, of the Russian monogerm introduction, PI 254575. The Russian monogerm introductions referred to in Sugar Beet Research, 1958 Report, page 5, are undergoing field evaluations at several locations. If these tests indicate that the Russian varieties are of value in sugar beet breeding in this country, an additional supply of seed will be needed.

Item B. SP 591104-0 - - - - - - - 200 grams

This is an increase, by J. O. Gaskill, of the Russian monogerm introduction, PI 254576. See comments for Special Item A.

Item C. SP 451069-0 - - - - - - - 2 pounds

Originally from a pooling of 9 European brands and maintained since about 1930 through seed increases without selection. The variety has been referred to as "Synthetic Check" or as "European Check" in variety tests conducted by the Sugar Beet Section and by Cooperators. Under conditions relatively free of disease, this synthetic variety has been very productive, but under disease exposure it has given low yields. An overwintering production of 100 pounds of seed is requested for use as a susceptible check in experimental programs.

Utilization of USDA Seed Releases, 1959

Items listed correspond to those listed in the release memorandum 1/

I. U. S. Sugar Beet Field Station, Salt Lake City, Utah.

Item 1. Tetraploid SLC 91 mm -- Each of the following companies will take a minimum of 10 grams or their share now: Amalgamated, American Crystal, Great Western, Holly, Spreckels, and Utah-Idaho. The available balance will be used for increase, probably in the Cache Valley of Utah by the Amalgamated Sugar Company. Amalgamated, American Crystal and Great Western have expressed interest to share in a small increase.

Item 2. Male-sterile tetraploid SLC 91 mm -- Will be increased similar to Item 1. The same companies wish a minimum of 10 grams or their share now as shown for Item 1.

Item 3. SLC 129-0 -- Will not be increased on a group basis. Each of the following companies will take a minimum of 10 grams or their share now: Amalgamated, American Crystal, Holly, Spreckels, Utah-Idaho. Great Western wishes to have sufficient seed to produce a 1 lb. increase.

Item 4. SLC 129 -- No increase requested. The following companies wish 10 grams or their share now: Amalgamated, American Crystal, Holly, Spreckels, Utah-Idaho.

Item 5. SLC 129 MS -- The same requests and increase arrangements apply to Item 5 as to Item 3.

Item 6. CT9A -- No increase requested. Amalgamated, Holly and Spreckels would like a few grams now. Utah-Idaho would like its share now.

II. U. S. Agricultural Field Station, Salinas, California.

Item 7 -- C9561 and Item 8 -- C9561HO -- Will be increased by the West Coast Beet Seed Company and used in combination with other seed lots as set forth by letter of June 30, 1959 from Sam C. Campbell. American Crystal, Spreckels and Utah-Idaho wish to have 15 grams each now. American Crystal, Holly, Spreckels and Union will share equally in the W.C.B.S. Company increase.

Item 9. C9561H1 -- No increase will be made. American Crystal, Great Western, Spreckels and Utah-Idaho want 10 grams each now. Holly and Union want proportionate share now. If any increase is made, American Crystal would like to share in such increase.

1/ Announced for release per memorandum from the Sugar Beet Section, Dewey Stewart, Head, dated June 3, 1959.

Item 10. C951 --

Item 11. C952 --

Item 12. C953 --

Item 13. C955 --

The above four items are for use in crossing programs only. Specifically, Great Western has asked for 20 grams each of Items 10 and 12. Holly asks for its share of the four numbers now, and Spreckels wants a few grams of the 4 numbers now.

III. Breeding for Improvement in Resistance to Leaf Spot and Black Root.

Item 14. SP 5931-0 -- The available quantity of seed will be utilized as follows: Utah-Idaho wants 15 grams now, Spreckels a few grams now, Holly wants 3 lbs. for tests now, and Great Western wants 5 lbs. now. American Crystal 50 grams now, however, would be willing to share in an increase.

Item 15. SP 59300-0 -- Spreckels and Holly want a few grams now, Utah-Idaho wants 15 grams now. American Crystal wants 50 grams now and would share in its proportion of an increase. Great Western would also share in its proportion of an increase.

IV. Breeding to Combine Resistance to Leaf Spot and Curly Top.

Item 16. SP 591-0 -- No increase is to be made. Holly and Spreckels would like a few grams now, American Crystal 25 grams now, Great Western 100 grams now, and Utah-Idaho wants its share now.

Item 17. SP 59E5-0 --(Proposed by letter from Dewey Stewart dated July 16, 1959) -- Increase to be made by F & M and Great Western.

V. Special Items Maintained by Sugar Beet Section.

Item A. SP 1103-0 -- Spreckels and Utah-Idaho want 10 grams each now. American Crystal, F & M, Great Western and Holly will share in increase by West Coast Beet Seed Company.

Item B. SP 591104-0 -- will not be increased. Few grams to be sent now to American Crystal, F & M, Holly, Spreckels, and Utah-Idaho. Small increases may be made by Holly and/or American Crystal.

Item C. SP 451069 -- To be increased by West Coast Beet Seed Company for American Crystal, F & M, and Great Western. Spreckels would like a few grams now.

1959 Seed Productions of 1958 Proposals for Seed Increase
(See 1958 Report, pp. 7-14)

1958 Proposals		1959 Productions	
Item	Breeder Seed	Producer and Designation	Seed (lbs.)
1	SLC 340	Utah-Idaho Sugar Co.	102
2	SLC 342	Utah-Idaho Sugar Co.	14
3	(CT5 X CT7)aa X CT9	Utah-Idaho Sugar Co.	8
4	CT7	Utah-Idaho Sugar Co.	7
5 1/	SLC 127 (Line 242)	Utah-Idaho Sugar Co.	10
6 1/	SLC 128 (Line 244)	Utah-Idaho Sugar Co.	4
7	C7569	West Coast Beet Seed Co.,F59-569	358
7a	F58-515HO X C7569	West Coast Beet Seed Co. F59-569H1	393
8	C8569HO X C7569	West Coast Beet Seed Co. F59-569HO	679
9	C8507rr	West Coast Beet Seed Co. F59-507	42
9a	F58-515HO X C8507rr	West Coast Beet Seed Co. F59-507H1	73
9b	C8569HO X C8507rr	West Coast Beet Seed Co. F59-507H2	67
10	C8507HOrr	No Increase	--
11	NB5	West Coast Beet Seed Co. F59-547 "A"	22
11a	MS of NB1 X NB5	West Coast Beet Seed Co. F59-547H1	764
12	C5547HO X NB5	West Coast Beet Seed Co. F59-547HO	55
12a	C7547H2 X NB5	West Coast Beet Seed Co. F59-547HOA	?
13	NB6	West Coast Beet Seed Co. F59-512	57
13a	C5547HO X NB6	West Coast Beet Seed Co. F59-512H1	115
14	C8503	No Increase	--
15	C8503HO	No Increase	--

1/ 1959 production used for further increase, 1959-1960.

1958 Proposals		1959 Productions	
Item	Breeder Seed	Producer and Designation	Seed (lbs.)
16	C884	No Increase	--
17	SP 5831-0	West Coast Beet Seed Co., Lot 9363	5948
18	SP 5832-0	No Increase	--
19	SP 5834-0	West Coast Beet Seed Co., Lot 9348	5120
20	SP 5835-0	No Increase	--
21	SP 5836-0	No Increase	--
22	SP 581-0	Utah-Idaho Sugar Co.	34
23	SP 586-0	Utah-Idaho Sugar Co.	21

PART II

DEVELOPMENT AND EVALUATION OF INBRED LINES AND HYBRID VARIETIES OF SUGAR BEETS

with emphasis on

Curly Top Resistance

Monogermness and High Quality

Foundation Projects 22, 23, and 15

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Cooperators conducting field tests:

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PROJECT 22 -- REPORT OF 1959 RESULTS

JEROME TEST FIELD FOR CURLY-TOP RESISTANCE, JEROME, IDAHO

By Albert M. Murphy

It has long been known that the curly-top disease is sporadic in nature. From long-time studies of the habits of the beet leafhopper in southern Idaho, the knowledge of the facts pertinent to a curly-top outbreak is well understood. The object of the Jerome test field is to manipulate the factors that are important in the epidemiology of the curly-top disease so that any desired level of exposure can be obtained within reasonable limits. This has greatly expedited the breeding program.

Due to marked differences in resistance of material furnished for testing in 1959, three levels of exposure were provided. They were: (1) light, more or less the same as the natural exposure for the area (2) moderate, and (3) heavy. Only the most resistant material was able to flourish under the heavy exposure.

The development of curly top got off to a slow start because May was both cold (-3.4°F) and wet (+.96" precipitation). On the other hand, June was very favorable for the development of curly top, being dry (-.57") and warm (+6.3°F). However, the high temperatures in June were extremely hard on the late-planted plots and in many cases stands were greatly reduced because the abnormally high temperatures came abruptly after the prolonged cool weather of May. These conditions, however, were ideal for the development of curly top, and the disease plus the continued hot weather rapidly separated the resistant and susceptible sorts.

TEST FIELD, JEROME, IDAHO, 1959

OWNER: Leon Aslett. Located six miles north and 1-1/2 miles west of Jerome, Idaho.

CROP HISTORY: Alfalfa, 1952; sugar beets, 1953 to 1959 inclusive. Barnyard manure and commercial fertilizer used for all beet crops.

PREPARATION FOR 1959 CROP:

1. Spread 14 loads (70 bu. each) of cattle manure per acre March 14-16
2. Disced
3. Broadcast 425 lbs. mixed fertilizer (24-20-0) per acre
4. Harrowed
5. Plowed March 20-24
6. Harrowed and leveled to prepare proper seed bed
   First planting April 20-21
   Second planting May 25-27
   Third planting June 8-9

To make the curly-top epidemic more severe, crosswise strips of R. and G. Old Type (1-300) 15 feet wide, were planted for the last two dates of planting on April 24. Virus-containing mother beets were set out in every other row of these strips April 27. Crosswise strips were used where yield tests were located.

IRRIGATIONS: All plantings irrigated immediately after planting and every week or ten days thereafter, depending on the weather.

EXPERIMENTAL DESIGN (Three groups in separate randomized blocks):

Group A - 7 varieties including Sugar Company hybrids
Group B - 8 inbred lines
Group C - 8 hybrids

HIGH NITROGEN LEVEL: On July 17 a heavy N side dressing (155 lbs. N per acre) was made on 20 rows through the field designated as the "High N Level" of the replicated variety test, Groups A, B. and C.

ROOT ROT: Root rot of undetermined origin affected occasional beets in several varieties. The monogerm inbred SLC 131 (6501) and the multigerm inbred CT9A (7096) were consistently affected with approximately 5 percent rotted beets.

PLOT SIZE: All plots consisted of two rows 50-feet long.

HARVEST OF REPLICATED TESTS: October 19-20

VARIETIES EVALUATED FOR CURLY-TOP RESISTANCE
JEROME, IDAHO, 1959

VARIETY	DESCRIPTION	MAY 25 PLANTING: TONS BEETS PER ACRE	MAY 25 PLANTING: C.T. Grade 8/28	MAY 25 PLANTING: BEETS 100' ROW At Harvest	APRIL 20 PLANTING: PERCENT CURLY TOP LOW N	APRIL 20 PLANTING: PERCENT CURLY TOP HIGH N
TEST 1A						
433	US 33 check	4.44	6.0	101		
4324	Klein E check	0.59	7.3	23*		
309+5	US 35 aa X Klein E	4.81	5.7	82	28.6	31.1
F54-4H7	CT9 MS Hyb.X Klein E Hyb.	4.34	3.7	58	10.7	8.6
E 67	CT9 MS X 5-142 mm	7.01	3.7	95	2.9	2.9
E 790	CT9 MS X CT5	9.72	3.0	123	2.5	1.5
E 792	91 MS mm X CT5	6.52	3.3	108	3.2	5.2
R 161	122 MS mm X SP 571-0	6.53	4.0	90	1.9	4.5
R 162	do. X SP 57102-0	6.74	3.3	116	6.9	7.4
TEST 1B						
028	US 41 check	9.95	2.7	137		
5070	CT7	5.18	2.0	102	2.0	1.3
7864	CT8 aa X Sibs	5.02	3.0	84	12.2	15.5
8504	Monogerm SLC 122-19	7.00	3.0	113	2.1	0.7
7096	CT9A	7.92	3.0	130	6.6	6.0
8505	Monogerm SLC 122-27	5.99	3.0	88	2.0	3.1
A2-90	CT9	5.30	2.0	83	1.7	2.8
8000	CT5 aa X Sibs	4.55	2.0	83	2.2	1.1
6501	Monogerm SLC 131	5.83	3.7	71	9.1	6.6
TEST 1C						
028	US 41 check	11.80	3.0	158		
8101	US 22 MS X SLC 122-19 mm	15.50	1.7	173	2.3	0.9
8216	(117 X 125) mm aa X 229 mm	11.87	3.7	140	8.2	2.0
E 790	CT9 MS X CT5	9.36	2.0	111	1.2	3.4
8104	US 22 MS X (CT5 X CT9)	13.08	1.7	124	1.7	2.2
7101	do. X CT5	10.72	2.0	136	3.0	2.9
8111	531H60 MS mm X (CT5 X CT9)	11.64	2.0	121	3.9	0.6
8125	do. X 122-19 mm	11.61	3.3	125	4.9	1.2
8210	(117 X 125) mm aa X 122-27 mm	14.17	3.0	143	4.8	0.5

* The poor stand at harvest for susceptible variety, Klein E, is accounted for by a high mortality after thinning.

EXPERIMENTAL DESIGNS: May 25 planting, three replicated plots of each variety but because of irregular stands yields were taken on only two replications. April 20 planting, three replications at each fertility level.

VARIETY TEST, JEROME, IDAHO, 1959
Including Amalgamated (E) and Utah-Idaho (R) Sugar Company Hybrids

(Three replicated plots of each variety)

Test 1A

S.L. NUMBER	DESCRIPTION	ACRE YIELD GROSS SUGAR POUNDS	ACRE YIELD TONS BEETS	PERCENT SUGAR	PERCENT PURITY	p.p.m. AMINO N	p.p.m. Na	p.p.m. K	BEETS 100' ROW	PER-CENT C.T.
	Low Nitrogen									
E 790	CT9 MS X CT5	9,925	26.7	18.5	90.0	1700	130	1800	105	2.5
F54-4H7	CT9 MS Hybrid X Klein E Hybrid	9,481	26.2	18.1	91.7	1900	170	2110	89	10.7
E 67	CT9 MS X 5-142 mm	8,724	23.5	18.6	89.9	1600	140	1740	94	2.9
E 792	91 MS mm X CT5	8,271	22.4	18.5	91.0	1400	160	1890	106	3.2
309+5	US 35 aa X Klein E	8,049	22.3	18.0	89.7	1600	150	2120	83	28.6
R 162	122 MS mm X SP 57102-0	7,930	22.2	17.9	91.3	1700	200	1940	86	1.9
R 161	122 MS mm X SP 571-0	7,498	20.9	17.9	92.7	1600	180	1900	75	6.9
General MEAN of all varieties		8,550	23.4	18.2	90.9	1600	160	1890		8.1
S. E. of MEAN		376	0.75	0.16	1.11	158	26	106		
Sig. Diff. (19:1)		1,159	2.32	NS	NS	NS	NS	NS		
S. E. of MEAN in % of MEAN		4.40	3.21							
Calculated F Values		5.44**	4.35*							
	High Nitrogen									
E 792	91 MS mm X CT5	10,156	28.5	17.8	88.4	3100	320	1970	119	5.2
E 67	CT9 MS X 5-142 mm	9,727	27.1	17.9	89.6	2400	310	2140	110	2.9
F54-4H7	CT9 MS Hybrid X Klein E Hybrid	9,696	29.1	16.7	87.7	3000	390	2400	98	8.6
E 790	CT9 MS X CT5	9,488	26.9	17.7	89.3	3300	310	2030	108	1.5
R 161	122 MS mm X SP 571-0	8,476	25.4	16.7	87.4	2800	460	2360	85	4.5
309+5	US 35 aa X Klein E	8,294	25.1	16.5	88.6	3100	350	2140	78	31.1
R 162	122 MS mm X SP 57102-0	7,923	24.0	16.5	88.4	3800	390	2110	111	7.4
General MEAN of all varieties		9,101	26.6	17.1	88.4	2800	360	2160		8.7
S. E. of MEAN		339	0.60	0.17	1.00	258	13	79		
Sig. Diff. (19:1)		1,045	1.85	NS	NS	2053	NS	244		
S. E. of MEAN in % of MEAN		3.72	2.26			9.21		3.66		
Calculated F Values		6.45**	4.73*	NS	NS	5.65**	NS	4.09*		

* Exceeds 5% point of significance (F = 3.00)
**Exceeds 1% point of significance (F = 4.82)

VARIETY TEST WITH INBRED LINES, JEROME, IDAHO, 1959

(Three replicated plots of each variety) Test 1B

S.L. NUMBER	DESCRIPTION	ACRE YIELD GROSS SUGAR POUNDS	ACRE YIELD TONS BEETS	PERCENT SUGAR	PERCENT PURITY	p.p.m. AMINO N	p.p.m. Na	p.p.m. K	BEETS 100' ROW	PER-CENT C.T.
	Low Nitrogen									
8000	CT5 aa X Sibs	9,038	24.3	18.5	89.0	1700	120	1570	97	2.2
6501*	Monogerm SLC 131	7,445	21.4	17.4	89.7	1500	170	2350	79	9.1
A2-90	CT9	6,617	18.9	17.5	89.8	1200	170	2000	79	1.7
5070*	CT7	6,320	16.7	18.8	90.0	2100	90	1430	105	2.0
7096	CT9A	6,283	18.1	17.3	89.9	1900	200	1690	89	6.6
8504	Monogerm SLC 122-19	6,227	17.3	18.0	91.8	1600	110	1770	88	2.1
7864	CT8 aa X Sibs	6,193	17.5	17.7	90.5	1600	150	2230	83	12.2
8505	Monogerm SLC 122-27	5,994	16.7	17.9	90.3	1600	120	1910	59	2.0
*One plot planted in wrong block										
General MEAN of all varieties		6,771	18.9	17.9	90.2	1700	140	1870		4.5
S. E. of MEAN		694	1.97	0.13	1.25	140	15	68		
Sig. Diff. (19:1)		NS	NS	0.40	NS	424	46	205		
S. E. of MEAN in % of MEAN				0.73		8.24	10.71	3.64		
Calculated F Values				17.40**		4.07*	6.29**	22.2**		
	High Nitrogen									
8000	CT5 aa X Sibs	8,656	24.8	17.4	90.2	2900	230	1880	106	1.1
6501	Monogerm SLC 131	8,525	26.7	16.0	85.3	3000	440	2510	85	6.6
5070	CT7	7,769	22.5	17.3	87.6	6000	110	1620	104	1.3
8504	Monogerm SLC 122-19	7,702	22.4	17.2	89.0	2600	190	1920	86	0.7
7864	CT8 aa X Sibs	7,276	21.5	16.8	87.2	2800	260	2290	96	15.5
7096	CT9A	6,688	20.2	16.5	87.0	3800	310	1850	91	6.0
A2-90	CT9	6,426	19.8	16.2	86.4	3000	370	2350	84	2.8
8505	Monogerm SLC 122-27	6,305	18.2	17.3	88.1	2400	250	2160	74	3.1
General MEAN of all varieties		7,426	22.1	16.8	87.7	3300	270	2080		4.6
S. E. of MEAN		459	1.38	0.28	1.05	238	36	184		
Sig. Diff. (19:1)		1,388	4.17	0.85	3.18	720	110	NS		
S. E. of MEAN in % of MEAN		6.18	6.24	1.67	1.20	7.21	13.33			
Calculated F Values		3.90*	3.97*	4.00*	2.91*	23.7**	7.75**			

* Exceeds 5% point of significance (F = 2.77)
**Exceeds 1% point of significance (F = 4.28)

VARIETY TEST OF HYBRID VARIETIES, JEROME, IDAHO, 1959

(Three replicated plots of each variety) Test 1C

S.L. NUMBER	DESCRIPTION	ACRE YIELD GROSS SUGAR POUNDS	ACRE YIELD TONS BEETS	PERCENT SUGAR	PERCENT PURITY	p.p.m. AMINO N	p.p.m. Na	p.p.m. K	BEETS 100' ROW	PER-CENT C.T.
		Low Nitrogen								
7101*	US 22 MS X CT5	10,716	28.8	18.5	90.6	1400	140	1800	116	3.0
E 790	CT9 MS X CT5	9,763	26.5	18.4	89.0	1700	160	1850	115	1.2
8104*	US 22 MS X (CT5 X CT9)	9,722	26.3	18.5	90.4	1500	200	2400	104	1.7
8101*	US 22 MS X SLC 122-19 mm	9,587	26.8	17.8	91.2	1500	170	1860	124	2.3
8111	531H60 MS mm X (CT5 X CT9)	8,783	24.0	18.2	91.1	1900	180	1880	100	3.9
8216	(117 X 125) mm zz X Line 229 mm	8,668	24.1	18.0	87.9	1800	200	1730	109	8.2
8125	531H60 MS mm X 122-19 mm	8,497	23.5	18.1	87.4	1500	180	1780	93	4.9
8210	(117 X 125) mm aa X 122-27 mm	8,330	23.1	18.0	90.3	1500	190	1730	105	4.8
*Based on average of only 2 replications										
General MEAN of all varieties		9,708	26.8	18.2	90.3	1500	170	196		3.8
S. E. of MEAN		500	1.09	0.32	1.79	289	31	105		
Sig. Diff. (19:1)		NS	NS	NS	NS	NS	NS	NS		
S. E. of MEAN in % of MEAN										
		High Nitrogen								
8104	US 22 MS X (CT5 X CT9)	10,057	28.9	17.3	88.7	3000	320	2090	98	2.2
7101	US 22 MS X CT5	9,922	28.7	17.3	88.8	2500	300	2880	114	2.9
8111	531H60 MS mm X (CT5 X CT9)	9,851	29.5	16.7	85.2	3500	390	2110	105	0.6
8210	(117 X 125) mm aa X 122-27 mm	9,425	27.7	16.9	88.0	2600	340	3060	117	0.5
E 790	CT9 MS X CT5	9,307	26.4	17.7	88.4	2000	280	1950	100	3.4
8216	(117 X 125) mm aa X Line 229 mm	9,237	26.6	17.4	88.7	2300	390	2040	104	2.0
8101	US 22 MS mm X 122-19 mm	8,985	27.2	16.5	87.4	3000	380	2250	118	0.9
8125	531H60 MS mm X 122-27 mm	8,864	26.4	16.8	87.6	2800	350	1930	102	1.2
General MEAN of all varieties		9,457	27.7	17.1	87.8	2700	350	2160		1.7
S. E. of MEAN		406	1.07	0.24	0.77	192	[illegible]	353		
Sig. Diff. (19:1)		NS	NS	NS	NS	592	NS	NS		
S. E. of MEAN in % of MEAN						7.11				
Calculated F Value						5.91**				

** Exceeds 1% point of significance (F = 4.28)

VARIETY TEST, TAYLORSVILLE, UTAH, 1959

By C. H. Smith

GROWER: Rell Swensen

SOIL TYPE: Welby fine sandy loam

PREVIOUS CROPS: 1955, grain to alfalfa; 1956 and 1957, alfalfa; 1958, grain.

FERTILIZERS AND CULTURAL PRACTICES: Applications of manure and commercial fertilizers were used in conjunction with previous crop rotation. In 1958, about 15 spreader loads of chicken litter and 200 pounds of ammoniated phosphate (20-40) per acre were applied and worked into the soil during seedbed preparation.

SOIL FUMIGATION: The soil was fumigated with Dow Telone at 20 gallons per acre in October by the plow method.

PLANTED: April 2

THINNED: Hand thinning, April 30

IRRIGATIONS: First irrigation June 9. Total of eleven irrigations by furrow.

CURLY TOP: Conspicuous in Klein E and other susceptible varieties but rare in resistant varieties.

HARVESTED: October 3, 1959. At harvest the tops were removed with a roto-beater and beets scalped with tractor-mounted scalping tool supplemented by long-handled hoe work. Beets were counted before pulling. The center row was taken from each plot for sugar analysis. These samples were weighed after washing to ascertain true tare percentage.

EXPERIMENTAL DESIGN: The variety tests considered here were of randomized block design. The beets were planted in 3-row plots with 20 inches between rows. Objective at thinning was 8 to 10 inches except in spacing test. Four-foot alleys were cut between plots. Effective plot length was 22 feet.

In Tests 1A, 1B, and 1C, blocks were alternated so that rough comparisons could be made between varieties in the three different tests.

VARIETY TEST, TAYLORSVILLE, UTAH, 1959
Including Amalgamated (E) and Utah-Idaho (R) Sugar Company Hybrids

(Six replicated plots of each variety) Test 1A

S.L. NUMBER	DESCRIPTION	ACRE YIELD GROSS SUGAR POUNDS	ACRE YIELD GROSS SUGAR % BASIS	ACRE YIELD TONS BEETS	PERCENT SUGAR	PERCENT PURITY	p.p.m. Amino N	p.p.m. Na	p.p.m. K	BEETS 100' ROW
F54-4H7	CT9 MS Hybrid X Klein E Hybrid	10,954	116	38.3	14.3	84.2	5000	600	3790	140
R 161	122 MS mm X SP 571-0	10,765	114	38.2	14.1	83.7	4900	580	3880	106
309+5	US 35 aa X Klein E	10,729	114	37.7	14.2	83.8	5700	630	3800	126
E 67	CT9 MS X 5-142 mm	10,511	112	35.1	15.0	84.2	4600	480	3360	123
E 792	91 MS mm X CT5	10,274	109	35.4	14.5	84.5	5200	560	3420	130
E 790	CT9 MS X CT5	10,188	108	35.1	14.5	84.7	4500	510	3230	135
433	US 33	9,520	101	35.3	13.5	81.1	5900	910	3880	129
R 162	122 MS mm X SP 57102-0	8,962	95	34.1	13.2	81.1	6700	800	3790	122
028*	US 41 (adjacent check)	9,406	100	34.1	13.8	81.9	6300	640	3830	129
General MEAN of all varieties		10,236		36.2	14.2	83.4	5300	630	3640	
S. E. of MEAN		223		0.65	0.22	0.70	261	38	90	
Sig. Diff. (19:1)		640		1.87	0.63	2.01	749	109	259	
S. E. of MEAN in % of MEAN		2.18		1.80	1.55	0.84	4.92	6.03	2.47	

*Not included in General Mean

VARIANCE TABLE

VARIATIONS DUE TO	DEGREES OF FREEDOM	MEAN SQUARES GROSS SUGAR	TONS BEETS	PERCENT SUGAR	PURITY	N	Na	K
Between varieties	7	2,787,483	16.20	2.06	12.98	322	1289	4755
Between replications	5	296,231	19.28	3.02	17.48	476	132	7054
Remainder (Error)	35	298,355	2.49	0.29	2.91	41	86	488
Total	47							
Calculated F Values		9.34**	6.51**	7.10**	4.46**	7.85**	14.99**	9.74**

**Exceeds 1% point of significance (F = 3.21)

VARIETY TEST WITH INBRED LINES, TAYLORSVILLE, UTAH, 1959

(Six replicated plots of each variety) Test 1B

S.L. NUMBER	DESCRIPTION	ACRE YIELD GROSS SUGAR POUNDS	ACRE YIELD GROSS SUGAR % BASIS	ACRE YIELD TONS BEETS	PERCENT SUGAR	PERCENT PURITY	p.p.m. AMINO N	p.p.m. Na	p.p.m. K	BEETS 100' ROW
6501	Monogerm SLC 131	10,270	107	40.4	12.7	81.1	5700	760	4150	124
7864	CT8 aa X Sibs	9,870	103	34.2	14.4	82.3	6800	390	3440	135
8000	CT5 aa X Sibs	9,411	98	33.5	14.1	83.3	6000	380	3210	126
8505	Monogerm SLC 122-27	9,396	98	33.7	13.8	84.5	4700	540	3580	124
8504	Monogerm SLC 122-19	9,196	96	34.4	13.4	81.8	5600	380	3990	124
7096	CT9A	8,909	93	32.4	13.7	82.8	7400	560	3390	127
A2-90	CT9	8,611	90	31.8	13.5	82.9	5800	590	3300	128
5070	CT7	7,912	83	27.3	14.5	82.4	8300	300	3010	130
028*	US 41 (adjacent check)	9,555	100	35.1	13.6	82.5	6300	700	3910	123
General MEAN of all varieties		9,195		33.5	13.8	82.7	6300	490	3510	
S. E. of MEAN		336		1.23	0.22	0.74	379	42	96	
Sig. Diff. (19:1)		964		3.54	0.64	NS	1087	121	275	
S. E. of MEAN in % of MEAN		3.65		3.67	1.59		6.02	8.57	2.74	

*Not included in General Mean

VARIANCE TABLE

VARIATIONS DUE TO	DEGREES OF FREEDOM	MEAN SQUARES GROSS SUGAR	TONS BEETS	PERCENT SUGAR	PURITY	N	Na	K
Between varieties	7	3,228,533	78.85	2.01	6.34	806	1,378	8,963
Between replications	5	3,439,101	14.32	2.28	8.19	216	148	2,239
Remainder (Error)	35	679,134	9.10	0.29	3.29	86	107	552
Total	47							
Calculated F Values		4.75**	8.66**	6.93**	1.93	9.37**	12.88**	16.24**

* Exceeds 5% point of significance (F = 2.30)
**Exceeds 1% point of significance (F = 3.21)

VARIETY TEST OF HYBRID VARIETIES, TAYLORSVILLE, UTAH, 1959

(Six replicated plots of each variety)

Test 1C

S.L. NUMBER	DESCRIPTION	ACRE YIELD GROSS SUGAR POUNDS	ACRE YIELD GROSS SUGAR % BASIS	ACRE YIELD TONS BEETS	PERCENT SUGAR	PERCENT PURITY	p.p.m. AMINO N	p.p.m. Na	p.p.m. K	BEETS 100' ROW
8111	531H60 MS mm X (CT5 X CT9)	11,390	113	38.7	14.7	85.3	4800	510	3570	124
8104	US 22 MS X (CT5 X CT9)	11,007	110	38.4	14.3	83.9	5400	570	3640	125
E 790	CT9 MS X CT5	10,715	107	37.6	14.3	84.6	5300	500	3450	132
7101	US 22 MS X CT5	10,479	104	37.2	14.1	84.7	5300	560	3390	130
8125	531H60 MS mm X 122-19 mm	10,432	104	37.3	14.0	84.2	5400	530	3760	121
8210	(117 X 125) aa mm X 122-27 mm	10,368	103	36.5	14.2	82.2	4600	520	3520	124
8101	US 22 MS X 122-19 mm	10,057	100	36.7	13.8	84.0	4600	600	3790	124
8216	(117 X 125) aa mm X Line 229	9,996	99	36.2	13.8	84.1	5100	670	3420	127
028*	US 41 (adjacent check)	10,051	100	35.8	14.0	82.3	5700	610	3760	125
General MEAN of all varieties		10,553		37.3	14.2	84.4	5000	560	3560	
S. E. of MEAN		263		0.71	0.27	1.02	24	36	89	
Sig. Diff. (19:1)		754		NS	NS	NS	68	103	256	
S. E. of MEAN in % of MEAN		2.49					4.68	6.43	2.50	

*Not included in General Mean

VARIANCE TABLE

VARIATION DUE TO	DEGREES OF FREEDOM	MEAN SQUARES GROSS SUGAR	TONS BEETS	PERCENT SUGAR	PURITY	N	Na	K
Between varieties	7	1,322,632	4.84	0.58	1.30	78	179	1387
Between replications	5	682,252	11.05	3.03	9.26	511	270	5376
Remainder (Error)	35	413,911	3.07	0.43	6.29	34	78	479
----- Total	47							
Calculated F Values		3.20*	NS	NS	NS	2.29*	2.29*	2.90*

*Exceeds 5% point of significance (F = 2.30)

SUMMARY OF UTAH AND IDAHO TESTS

For the replicated field tests at Jerome, Idaho, and Taylorsville, Utah, three varietal groupings were made, 1A, 1B and 1C. Group A included three high-yielding hybrids, E 67, E 790 and E 792, furnished by the Amalgamated Sugar Company and two CTR-LSR hybrids, R 161 and R 162, furnished by the Utah-Idaho Sugar Company. Group B was made up of inbred lines and Group C was made up of new hybrids with E 790 (CT9 MS X CT5) included a second time for comparison.

Hybrid E 67 (CT9 MS X 5-142 mm), furnished by the Amalgamated Sugar Company, was especially attractive. The roots were always clean and well shaped, the yield was good, and the sugar percentage was the highest in all tests. Among the newer monogerm hybrid combinations, SL 8111, MS mm X (CT5 aa X CT9), was highly attractive. This 3-way hybrid produced a yield of 11,388 pounds gross sugar per acre at Salt Lake City, which surpassed all other varieties. We had been especially interested in the F_1 pollinator (CT5 aa X CT9) used in the production of this 3-way hybrid because both CT5 and CT9 have shown good combining ability and both have produced good hybrids. The F_1 combination (CT5 aa X CT9) was highly vigorous and much more desirable for use as the pollinator in the seed field.

Beets from the Jerome, Idaho, tests were taken to Nyssa, Oregon, where sugar determinations were made by the Amalgamated Sugar Company. Frozen pulp was taken from the same samples and further chemical analyses were made at Salt Lake City. Sodium, potassium and nitrogen values were made by Myron Stout. Sodium and potassium were determined with a flame spectrophotometer. Amino nitrogen was determined by the Stanek-Pavlas method, using the spectrophotometer as an absorption instrument. The "Amino N" values reported are based on the concentration of glutamine necessary to produce the same color. True "amino N" would be 0.097 times the values given. Sugar and purity (apparent purity) determinations were made by C. H. Smith. G. K. Ryser and Earl H. Ottley were responsible for all statistical analyses.

Designations:

MS = Cytoplasmic male sterility
aa = Mendelian male sterility
mm = Monogerm

EASY BOLTING SUGAR BEET VARIETIES AT BRAWLEY, CALIFORNIA, 1958-59

Planted September 16 and 17,1958
Harvested April 15 and 16, 1959

By Charles Price and Kenyon Beatty

Varieties selected from the Salt Lake City breeding program were included in the Brawley, California, 1958-59 variety test. There were two sets of nine varieties with Dr. McFarlane's high-yielding hybrid US H2 inserted for a check. One set of varieties (Test I) was made up of cytoplasmic male-sterile (MS) hybrids and the other set (Test II) was made up of Mendelian male-sterile (aa) hybrids with both parents monogerm. Sugar determinations were not made for the 1958-59 test, because it was felt that this information was relatively well established for the particular hybrids under test. The information on yielding ability and type of root growth was very informative, however. Records were also obtained on the extent and rate of bolting and degree of male sterility for the hybrids which flowered.

All hybrids with both parents monogerm (mm) were definitely inferior in yield and in root type. All multigerm hybrids produced well-formed long, straight roots indicative of a deep, well-drained soil. US H2 beets were especially long, straight and uniform. Roots from the hybrids with both parents monogerm, however, were irregular and some were poorly shaped. The most striking peculiarity was the tendency for these monogerm beets to turn to one side or the other rather than to grow straight down.

The opportunity of seeing samples of beets from the Salt Lake City breeding program included in the Brawley plantings is of distinct value, because of the opportunity of seeing the beets in April; whereas one must wait until October or November in the intermountain area for the same observations. The early information makes it possible to select and propagate breeding stocks more intelligently.

[redacted] BOLTING SUGAR BEET VARIETIES AT BRAWLEY, CALIFORNIA, 1958-59

TEST I

Single-row plots 40 feet long
with 30 inches between rows

Planted Sept. 16 and 17, 1958
Harvested April 15 and 16, 1959

VARIETY	PARENTS	ACRE YIELD BEETS	HARVEST COUNT 100'	BOLTERS MARCH 23
		TONS	NUMBER	PERCENT
7106	US 22 MS X SLC 125 mm	21.3	161	3.57
US H2	California #663H1	20.9	149	0.16
6103	US 22 MS X CT5	20.5	156	28.00
8102	do. X 747.17 mm (125 hybrid)	20.4	156	5.94
8104	do. X (CT5 X CT9)	20.1	160	15.49
8101	do. X SLC 122-19 mm	19.1	157	7.02
8132	7121 MS mm X Line 229 mm	18.0	155	14.49
8126	do. X SLC 122-27 mm	17.7	157	5.40
8125	531H60 MS mm X SLC 122-19 mm	15.7	150	5.36
8121	7121 MS mm X SLC 122-16 mm	15.7	145	8.30
General MEAN of all varieties		18.9		
S. E. of MEAN		.59	5.05	
Sig. Diff. (19:1)		1.66	14.27	

VARIANCE TABLE (10 X 10 Latin Square)

	Degrees of freedom	MEAN SQUARE
		TONS BEETS
Between replications	9	7.00
Between columns	9	13.91
Between varieties	9	42.77
Error	72	3.45
Total	99	
Calculated F value		12.38**

* Significant F value 5% point (2.01)
** Significant F value 1% point (2.67)

EASY BOLTING SUGAR BEET VARIETIES AT BRAWLEY, CALIFORNIA 1958-59

TEST II

Single-row plots 40 feet long
with 30 inches between rows

Planted Sept. 16 and 17,1958
Harvested April 15 and 16, 1959

VARIETY	Monogerm parents aa mm X mm	ACRE YIELD BEETS TONS	BEET COUNT 100' NUMBER	BOLTERS MARCH 25 PERCENT
US H2	California #663H1	23.4	142	0.18
8210	(117 X 125) X SLC 122-19 mm aa mm	17.1	143	0.87
8288	Line 229 mm aa X SLC 122-16 mm.	17.0	149	1.01
8287	Line 229 mm aa X do.	16.9	152	2.63
8255	(122 X 125) mm aa X do.	16.2	148	3.88
8254	(117 X 125) mm aa X do.	16.0	144	4.17
8256	(125 X 125) mm aa X do.	14.7	145	2.75
8253	(609 X 609) mm aa X do.	14.3	145	2.77
8252	(122 X 609) mm aa X do.	13.4	130	3.65
8251	(117 Xb609) mm aa X do.	13.2	137	3.10
General MEAN of all varieties		16.24		
S. E of MEAN		0.56	5.40	
Sig. Diff. (19:1)		1.59	15.27	

VARIANCE TABLE (10 X 10 Latin Square)

	Degrees of freedom	Mean Square Tons beets
Between replications	9	12.50
Between columns	9	27.39
Between varieties	9	84.60
Error	72	3.14
Total	99	
Calculated F. values		26.97**

* Significant F value 5% point (2.01)
** Significant F value 1% point (2.67)

SOME STUDIES OF POLLEN RECOVERY IN SUGAR BEETS

By F. V. Owen and George K. Ryser

In crosses with the annual male-sterile(sixth backcross to the type O annual SLC 03) most cases of pollen recovery appeared in segregating populations. Therefore, it was assumed that the pollinators were heterozygous for pollen-recovery genes. It now appears possible that part of this assumed heterozygosity may have been due to environmental variability with respect to the F_1 hybrids. Preliminary studies three years ago indicated that certain sublines of the leaf-spot-resistant variety US 201 might be a desirable source for pollen-recovery genes, so an extended study was made. In 1958 the subline US 201-20 was identified as a possible homozygous pollen-restoring line. Our full assurance that this line was homozygous necessitated a more careful study of environmental influences. Hybridization with the isogenic annual MS X US 201-20 gave results as follows:

	Classification of offspring			
	MS white anthers	Semi-MS yellow anthers	Pollen producers	Total plants
	Percent	Percent	Percent	Number
F_1 observed	0	0	100*	113
b_1 observed	49.6	50.0	0.4	234
Expected	50	50		234
F_2 observed	27.5	28.9	43.6	149
Expected	25	75		149

* Semi-male-sterile when grown under unfavorable conditions

The F_1 Generation (Annual [redacted] X US 201-20)

All F_1 plants were vigorous annuals and were remarkably uniform in growth habit and foliar characteristics. Sometimes these vigorous plants produced great quantities of viable pollen but there was striking variability from plant to plant and from different branches of the same plant. At first these seemingly erratic results were puzzling, but careful observations showed that these plants were very sensitive to environmental variability. When flowering plants were subjected to somewhat unfavorable conditions--low temperatures or under moisture stress in small pots--pollen production was poor. Sometimes the majority of the anthers were shrunken and did not dehisce.

A careful study was made of these F_1 plants by potting them separately, cutting back flowering branches, and inducing new luxuriant growth. This experimental work was not conducted in such a way that statistical data could be easily collected but many striking demonstrations were produced. When grown in 6" pots which were allowed to dry between irrigations, these plants produced badly shrunken anthers which did not dehisce. The same plants, later transplanted to larger pots and irrigated adequately, produced large quantities of viable pollen. These F_1 plants appeared much more sensitive to these unfavorable conditions than plants having parentage with a history of normal pollen production.

The b_1 Generation Annual MS X (Annual MS X US 201-20)

In the b_1 generation growth was also vigorous and uniform but pollen production was drastically suppressed as compared with the F_1 generation. Only one plant was classified as a possible pollen producer. Most plants classified as semi-male-sterile bore badly shrunken yellow anthers without a trace of viable pollen. Fifty percent of the plants bore white empty anthers typical of the recurrent MS annual female parent.

The F_2 Generation (MS X US 201-20) Self-pollinated

Vigor was reduced in the F_2 generation but some individual plants appeared to be excellent pollen producers. Approximately 25 percent of the plants bore white empty anthers.

Genic emasculation from female parentage

Experience with cytoplasmic male sterility has shown that individual MS plants which look more or less alike do not necessarily breed alike. The annual MS line used as the female parent in hybridization to US 201-20 has more emasculating power than many cytoplasmic male-steriles. This emasculating power is illustrated in the backcross MS X (MS X US 201-20). This backcross population was so strongly emasculated under the conditions where the plants were grown (both field and greenhouse) that the population might have been acceptable for female parentage for practical hybridization purposes. Yet from the parentage we know that some of the b_1 generation plants (presumably 50 percent) carried a powerful recovery gene in the heterozygous condition. Much work yet remains to unravel all important genetic information, because the two-gene hypothesis is not a full explanation. Along with this study it will be important also to study environmental influences much more carefully.

SELECTION AND BREEDING FOR CHEMICAL AND PHYSIOLOGICAL CHARACTERS

By Myron Stout, F. V. Owen and G. K. Ryser

Further data were obtained in 1959 on the relative chemical analysis of several inbred lines selected in previous years and on the performance of some of their hybrids.

The most consistent differences in chemical analysis were obtained on inbred lines, again proving the genetic inheritance of these characteristics. The inbred CT7 was consistently high in amino nitrogen and sugar and was very low in sodium content. The new monogerm line SLC 131 produced large roots relatively low in sugar and very high in sodium content. The amino nitrogen content of SLC 131 was comparatively low. As in previous years, relatively high sugar and purity values were obtained on inbreds CT5 and CT8. These inbreds were intermediate in amino N, sodium and potassium. The Ovana fodder beet produced extremely high-yielding roots that were very low in sugar percentage and respiration rate. Although the potassium content was high, the relationship between potassium and sodium was low, similar to data obtained in 1952 on several fodder beets and red garden beets.

The hybrid SLC 630 produced an extremely high yield of sugar per acre. Hybrids SLC 630 and its sister combination SLC 631 were comparatively low in respiration rate. Purity values were not determined on the Ovana hybrid test in 1959.

The results obtained in 1959 again show that those characteristics of sugar beets that are related to "quality" are affected by both genetic inheritance and nutrition, as well as disease, and that these quality factors are not incompatible with high yield.

INDIVIDUAL BEET ANALYSES WITH EMPHASIS ON Na AND K RELATIONSHIPS OF THE OVANA FODDER BEET AND HYBRIDS INVOLVING OVANA PARENTAGE

TAYLORSVILLE, UTAH, 1959

S.L. NUMBER	VARIETAL DESCRIPTION	ACRE YIELD GROSS SUGAR POUNDS	ACRE YIELD TONS BEETS	TOTAL NUMBER BEETS	AVERAGE WT. DECA-GRAMS	SUGAR PERCENT	RESPIRATION CO_2/kg/hr Mg.	AMINO N PERCENT	p.p.m. ÷ 10 Na	p.p.m. ÷ 10 K	RATIOS GRS.SUGAR / N	RATIOS % SUGAR / N	RATIOS K / Na
630	((US 35 X (US 35 X Ovana)) X CT8 (Single aa Plant)	12,760	44.0	20	137±11.6	14.5±0.36	62±2.98	.57±.032	56±6.4	367±10.8	224	25.4	6.55
631	((US 35 X (US 35 X Ovana)) X CT8 (Single aa Plant)	11,184	38.3	50	119±27.7	14.6±0.79	60±1.43	.51±.027	56±3.9	370±7.8	219	28.6	6.61
50+10	F_2 (US 35 X Ovana) X High-sugar (23 aa Plants) lines	11,890	44.7	26	134±19.3	13.3±0.45	62±2.21	.60±.142	63±5.0	403±10.9	198	22.2	6.40
028	US 41	11,889	38.6	26	113±10.9	15.4±0.40	70±2.59	.45±.045	65±4.8	380±12.8	264	34.2	5.85
308	Ovana	8,960	78.6	58	218±17.3	5.7±1.59	50±1.55	.46±.024	144±3.4	454±47.6	195	12.4	3.15

EXPERIMENTAL DESIGN:

Unreplicated single-row plots 22 feet long. There were two single rows of the Ovana fodder beet and the hybrid SL 631. All individual beets were sampled separately by cutting a cylindrical plug from each. One 26-gram portion of the plug was used for sugar and other chemical analyses and one 10-gram portion was used to determine the respiration coefficient CO_2/kg/hr(milligrams CO_2/ per Kg. beets per hr.)

Scarcity of seed of the hybrids SL 630 and SL 631 limited the scale of the experiment but the data clearly show the Na and K relationships in comparison with US 41. The Ovana fodder beet was 122 percent higher in Na content but only 19 percent higher in K content.

BEET SUGAR DEVELOPMENT FOUNDATION PROJECT 15

By Myron Stout

SOIL-PROFILE NITRATE DISTRIBUTION STUDIES

The nitrate nutrition of sugar beets has been shown to have a very profound effect on both yield and quality. High nitrate uptake, especially early in the season, stimulates the growth of leaves and thereby greatly increases yields of beets. High nitrate uptake near harvest also stimulates the growth of new leaves and reduces sugar percentage and quality. Excessive nitrate late in the season, also reduced actual yields of roots. Gardner and Robertson (1943) stated that an increase of .025 percent of nitrate nitrogen in the roots at harvest reduced the percentage of sugar about 1 percent and that the relationship was apparently linear. Neither the effect of high nitrate uptake on early development nor the forty-fold relationship between nitrate and sugar at harvest should be ignored. Both high yield and good quality have been achieved simultaneously but with deplorable inconsistency.

Stimulation of early growth by good seed-bed preparation, irrigation, foliar feeding and other methods have attractive possibilities for improving both yield and also quality, by increasing early growth and thereby depleting nitrates before harvest. Pre-harvest depletion of nitrate is primarily aimed at possible quality improvement. The present report is concerned with the latter part of the problem.

Holden Plot (8000 South 300 East, Midvale, Utah)

Fine sandy loam soil--hard clay at 30-36 inches depth. A green-manure crop of barley was plowed into the soil. The field was harrowed, then a heavy application of phosphate and nitrate fertilizer was broadcast, then re-harrowed. Seed was planted on flat double beds 40 inches between furrows. The first planting date, July 30; second planting date, August 17.

Irrigations were frequent after planting to insure germination and emergence. There was no flooding, although furrows were quite shallow. Soil-profile samples were taken at four locations in the field September 10, following an irrigation. Lateral percolation of moisture had not reached the center of the beds in some places but it had in others, providing an excellent opportunity to study lateral as well as vertical distribution of nitrate. Six one-half-inch surface samples were taken from the bottom of the furrow to the opposite shoulder of the bed, as shown in table 1. Two more surface samples were taken in the center of the bed, one where surface moistening had reached center and the other where the center of the bed was still dry. The moist sample showed 5500 ppm nitrate nitrogen, while the dry sample contained only 1270 ppm. (All samples were sealed in glass with 2-3 ml. of toluene to prevent biological change before drying and chemical analysis). The data in table 1 show very little nitrate in the furrow but progressively increasing to about 2000 ppm near the center of the bed. Samples were again taken at different depths across the bed on September 15, following a fairly heavy rain. The data (table 1) show that the high concentration of nitrate in the surface had been leached to lower levels of soil by the rain and also that the concentration in the lower levels of soil were conspicuously greater near the center of the bed. Some showers intervened between September 15 and September 23 when more samples were taken, but the relatively high nitrate concentration in the bottom of the furrow, as well as across the bed, show the predominant movement was upward--and probably laterally toward the furrows. Nearly 0.65 inches of rain occurred intermittently before samples were again taken September 30. However, two or three days of comparatively dry weather allowed some concentration to redevelop in the surface, but the movement was again definitely away from the furrow toward the center of the bed.

The data in the foregoing tests substantiate the observations made on lettuce bed rows at Tucson, Arizona by McGeorge and Wharton, regarding lateral as well as vertical profiles. The present tests show an exaggerated pattern in the surface because of the thin sampling depth of the top samples. The intermittent occurrence of rain, as well as furrow irrigations, made the present tests especially informative. Many other studies regarding salinity movement and concentration show essentially the same patterns, but nitrate salts are probably the most soluble of salts and therefore move ahead of other salts or at a greater concentration with soil-water front as it moves through soil.

The science of solvent chromatography is based on differential solubility of solute in solvent. If we can visualize a three dimensional, or solid chromatogram, with water as the solvent and nitrates having Rf values near unity we can pretty well predict the movement of nitrate in the soil.

Considerable speculation and probably some data have been presented concerning the loss of nitrate from soils due to leaching under irrigation. There may be some nitrate lost in this way under excessive irrigation and waste water run-off on some soils, particularly those having gravelly or sandy subsoils. However, most authors agree that considerably more than half the water normally applied to produce a crop is lost by evaporation and transpiration rather than sub-soil drainage. If this is true, some data secured on irrigation and drainage canal waters in the Granger area this past Fall--as well as below-surface soil analyses--can be used as bases for thought on the subject. The free-water-surface evaporation rates in Table 1 are also pertinent to this problem.

Water samples were taken October 6, 1959, from the canal furnishing irrigation water to the Granger area. Drainage water from the same area

was also sampled. The data are presented in Table 2. Even the highest nitrate content measured in the drainage water had only twice the nitrate content of the irrigation water. Twenty-four soil profile samples were taken between October 5 and October 8. The deepest samples taken in the five fields averaged about 0.6 ppm of nitrate nitrogen. If less than half the irrigation water reached the drains (as most writers agree), then the irrigation water must have supplied more nitrate to the soil than it leached out. Bottom soil samples at the Holden plot, on sandy soil that was very heavily fertilized late in the season, averaged about 4.5 ppm on September 30. Earlier sampling of drainage water may show higher nitrate content.

- -

TABLE 2 -- Nitrate content of Irrigation and Drainage water in the Granger Area, collected October 6, 1959

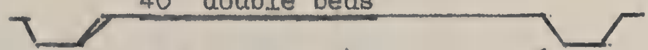
SOURCE OF WATER	NITRATE N
	ppm
North Jordan Canal, 2800 West 4100 South (irrigation water)	1.24
Drainage canal, 3500 South about 2300 West	2.48
Drainage canal, 3500 South about 1600 West	0.68
Jordan River, 2100 South, about 1400 West	1.98
Cold tap water, 1810 South Main Street	0.27

TABLE 1. Vertical and horizontal distribution of nitrate nitrogen in relation to irrigation, evaporation and rainfall on forty-inch double-beds planted to sugar beets July 30 and August 17, 1959. Holden plot (80th South, 3rd East, Midvale, Utah) Fine sandy loam soil with clay 30 to 36" from surface.

Legend - sample depth

A = 0 - 1/2"
B = 1/2" - 6"
C = 6" - 12"
D = 12" - 24"
E = 24" - 36"

40" double beds



Nitrate-N PPM

DATE	RAIN [1] Inches	Evap. [2] Inches		1	2	3	4	5	6
April	1.61	7.34							
May	2.05	8.71							
June	1.38	12.95							
July	0.19	14.12							
August	1.76	12.94							
September	1.66	8.09							
October	0.22	4.94							
Total	8.87	69.09							
Sept. 1	-- [3]	0.45							
2	--	0.35							
3	--	0.35							
4	--	0.41							
5	--								
6	--								
7	--		A				5500 moist soil		
8	--	1.50	A				1270 dry soil		
9	--	.56							
10	--	.30	A	3	170	1080	1800	2060	880
11	--	.40							
12	--								
13	0.03		A	3	2	8	6		
14	0.60	.84	B	10	1	88	57		
15	0.19	.32	C	9	2	25	29		
16	--	.19	D	7	2	11	12		
17	--	.14	E	4	4	7	8		
18	--	.23							
19	0.19								
20	.05								
21	.18	.57	A	22	188	460	1900		
22	--	.23	B	22	19	66	118		
23	0.03	.15	C	11	1	15	18		
24	T	.12	D	5	2	10	10		
25	0.27	.26	E	4	4	6	4		
26	0.01								
27	0.29								
28	0.05	.41	A	2	5	550	170		
29	T	.14	B	3	7	186	69		
30	--	.17	C	3	3	25	16		
			D	2	4	7	7		
Total	1.89		E	2	4	7	5		

1/ Inches precipitation at Salt Lake Airport
2/ Inches evaporation Morton Salt Company plant
3/ Inches precipitation 7200 South 300 East - 1.4 miles from plot

JONES BROTHERS FIELDS, 7200 and 7444 South 2200 West, West Jordan, Utah

In cooperation with the Agricultural Research Department of the Utah-Idaho Sugar Company, a comparison was made of the effect of deep versus shallow furrows made at the last cultivation (about August 1) on the nitrate distribution in the soil profile and on yield and quality of beets at harvest.

The two fields on which the tests were made are located about three blocks apart. The soil types are practically the same and other practices were very similar; therefore, the comparisons are presented together in Tables 3A and 3B.

The soil was a tightly packed silty clay loam. The fields were irrigated only in alternate furrows after the deep or shallow-furrowed strips were formed. The soil in both fields was very hard and quite dry throughout the fall months. There was no flooding except at the bottom of the fields below the experimental area. Irrigation furrows cut quite deeply at the top and filled up at the bottom of the field due to the silty nature of the soil rather than the slope of the fields. There was little observable difference in the irrigated furrows after irrigation, but the depth of the furrows that were not irrigated was easily distinguishable. No comparisons were possible, therefore, between flooding and well-formed dry ridges in the beet rows. However, some very consistent differences were observed between adjacent pairs of sample areas in both fields as well as consistent differences with respect to the top and bottom of each field.

Sampling equipment consistently penetrated the soil in the deeply furrowed strips more easily, and these samples were evidently higher in moisture content. This observation was verified by the higher nitrate content of soil below the surface at the first date of sampling shown in Table 3A. There was little nitrate left below the surface 1/2 inch at the second sampling date,

but the data indicate greater depletion of nitrate in the deeply furrowed strips.

The average analysis of three 10-beet samples from each test location reported in Table 3B show that the average weight of beets, as well as sugar percentage and quality, were consistently in favor of the beets from the deeply-furrowed strips. Although the lack of replications of the field treatments under study precludes any useful application of statistical analysis, the consistent differences observed between matched sampling areas in the two fields lends credence to the usefulness of the data.

Probably the most significant observation in the test is that of the nitrate distribution in the soil. There was a high concentration of nitrate in the top 1/2 inch and little below that level, even though considerable rainfall occurred during the sampling period. This indicates that most of the rain was shed into the furrows where nitrate was already low due to irrigation, or was funnelled to the crown area of the beets by the petioles. Soil samples were taken between the beets. A total of 0.86 inches of rain was recorded in Midvale (about 2 miles east of the plots) September 15 and 16, before samples were taken September 17. Light showers also occurred each of the five days before the samples were taken on September 28. Nearly 0.3 of an inch was recorded September 27. Unprotected soil would undoubtedly have shown values far different from those in Table 3A (compare with Table 1).

Another observation was made in connection with nitrate sampling in other fields, especially in flooded soils covered with very heavy foliage. Many sugar beet roots could be seen on top of the soil following the rains during late September. This may be a significant factor in quality deterioration when rains occur in the fall before the beets are harvested. The soil, as well as the sugar beet analyses in Table 3, however, indicates that little harm was done to the beets harvested October 10. No pre-harvest samples were taken to prove or disprove this point.

TABLES 3A and 3B -- The effect of depth of furrows on soil profile nitrate, yield and quality of beets at harvest.
Strips furrowed about August 1, Harvested October 10, 1959

TABLE A Soil Data

	Sample depth Inches	DATES OF SOIL SAMPLES 8/11	8/31	9/17	9/28	10/8
		Nitrate nitrogen, ppm				
Shallow	0 - 1/2	462	612	668	494	378
	1/2 - 6	18	18	10	11	1
	6 - 12	13	1	2	1	1
	12 - 24	5	4	1	1	1
	24 - 36	2	2	-	-	-
Deep	0 - 1/2	358	588	405	448	400
	1/2 - 6	25	5	12	4	1
	6 - 12	18	1	1	1	1
	12 - 24	14	1	1	0	1
	24 - 36	3	1	-	-	-

TABLEA B Harvest data

Paired sample Number 2/	Wt. per beet Lbs.	Sugar %	Purity %	Amino N 1/ %	Na ppm	K ppm
1	1.67	16.34	89.9	0.16	231	2622
2	1.66	15.87	88.8	0.17	370	2614
3	1.67	17.70	87.3	0.35	239	2731
4	2.26	15.71	86.7	0.34	392	3210
Average	1.82	16.40	88.2	0.26	308	2794
1	1.79	18.53	90.5	0.18	172	2323
2	2.11	17.72	90.1	0.26	331	2542
3	2.04	18.40	88.4	0.30	295	2917
4	2.76	17.07	88.5	0.29	311	2961
Average	2.18	17.93	89.4	0.26	277	2687

1/ Amino nitrogen as glutamine

2/ Samples 1 and 2 Leslie Jones farm; 3 and 4, Melvin Jones farm

1 and 3 = top; 2 and 4 = bottom of field

SUGAR BEET VARIETY TEST, UNIVERSITY PARK, NEW MEXICO, 1959

Conducted in Cooperation with the New Mexico Agricultural Experiment Station

By J. C. Overpeck

Harvested December 1-2,1959

Variety	Tons Roots per Acre		Curly Top Readings[1]		Vigor Readings[1]	
	Feb. 18 Planting	March 18 Planting	Feb. 18 Planting	March 18 Planting	Feb. 18 Planting	March 18 Planting
SP 58101-0	9.40	13.76	5.2	5.0	5.0	5.2
U-I R 161	12.58	7.79	3.8	5.5	4.2	5.5
U-I R 162	6.45	6.34	6.4	7.0	5.8	7.0
863 H7	3.85	2.53	7.8	8.6	6.8	8.4
US H2	10.69	12.12	4.4	4.8	4.4	5.2
US 22/4	18.40	21.80	3.0	4.2	2.8	3.7

1/ Readings made September 11 on a scale of: 1 = most favorable; 10 = least favorable.

Comment: In this test there was a heavy loss of plants due to an undetermined cause, beginning in midsummer and continuing until harvest. The varieties differed strikingly in plant survival. Leafhopper infestation occurred early in the season, and curly top exposure was severe. The entries with the highest curly top resistance in this test gave the highest plant survival and the highest calculated root yield. The acre yields are given as averages of 4 to 6 harvested plots without statistical analysis of the data.

PART III

INTERSPECIFIC HYBRIDIZATION

- -

POLYPLOIDY IN RELATION TO ROOT YIELD AND SUCROSE PERCENTAGE

Foundation Project 11

Helen Savitsky V. F. Savitsky

Cytologist and Geneticist, respectively, Beet Sugar Development Foundation; and Collaborators, Crops Research Division, ARS, USDA, working under the supervision of the Beet Sugar Section.

OBTAINING NEW TETRAPLOID STRAINS

By Helen Savitsky

Previous investigations in polyploidy indicated that different tetraploid lines and populations do not always show the same phenotypical expression of root weight and percent sucrose as their original diploid ancestors. It is possible that different types of sugar beets exhibit a different reaction toward polyploidy. Probably some of them will give better results than others.

New tetraploid strains are under production in order to study the types of sugar beets most valuable in the tetraploid stage and also to study disease resistance in polyploids.

Seed of the following nine strains were treated with colchicine in 1958:

One Z-type mm inbred line
One Z-type self-sterile MM population, Janasz
One leaf-spot-resistant mm inbred line
One mm self-sterile population high in curly-top resistance
One E-type mm inbred line
Two cytoplasmic male-sterile lines with cytoplasm from different origins
One F_1 hybrid between two inbred lines
One Mendelian male-sterile line

Seedlings which were affected by colchicine were transplanted to cylinders and exposed to thermal induction during the winter. In the spring they were transplanted to the station field. Pollen was examined in all plants except in male-sterile lines. In the majority of plants the chloroplast number was also checked. Plants which produced diploid gametes (according to the size of pollen grains) were selected as tetraploids. From 1038 plants investigated, 460 (or 45.2 percent) were tetraploid. In every strain not less than 50 tetraploid plants were obtained. In the majority of strains about 80 tetraploid plants were selected. The high percentage of tetraploid plants indicates high effectiveness of the applied method of treatment.

Tetraploid plants within a strain were intercrossed by exchanging pollinating bags. Seeds obtained in this way were planted, and from every strain 100 plants were grown for chromosome checking. Selection of tetraploid plants and production of pure pedigreed lines will be made in 1960.

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New tetraploid strains are under production in order to study the types of sugar beets most valuable in the tetraploid stage and also to study disease resistance in polyploids.

Seed of the following nine strains were treated with colchicine in 1953:

One Z-type [illegible] inbred line
One Z-type self-sterile [illegible] population, Janasz
One leaf-spot-resistant [illegible] inbred line
One [illegible] self-sterile population [illegible] curly-top resistance
[illegible] S-type [illegible] inbred line

Seedlings which were affected by colchicine were transplanted to cylinders and exposed to thermal induction during the winter. In the spring they were transplanted to the station field. Pollen was examined in all plants except in male-sterile lines. In the majority of plants the chloroplast number was also checked. Plants which produced diploid gametes (according to the size of pollen grains) were selected as tetraploids. From 1038 plants investigated 440 (or 42.4 percent) were tetraploid. In every strain not less than 30 tetraploid plants were obtained. In the majority of strains about 60 tetraploid plants were selected. [illegible] percentage [illegible] indicates [illegible] treatment.

Tetraploid plants within a strain were intercrossed by exchanging pollinating bags. Seeds obtained this way were planted, and from every strain 60 plants were grown for chromosome checking. Selection of tetraploid plants of pure pedigreed lines will be made in 1954.

ALLOPOLYPLOID INTERSPECIFIC HYBRIDS BETWEEN SECTION VULGARES AND SPECIES OF THE SECTION PATELLARES

By Helen Savitsky

In 1958, mainly tetraploid and diploid viable interspecific hybrids were obtained from crosses of different B. vulgaris races with the species of the section Patellares. In 1959, the efforts were concentrated on obtaining triploid hybrids. Triploid hybrids were obtained from hybridization of tetraploid sugar beets and tetraploid Swiss chard with diploid species B. procumbens and B. webbiana. They carried two genomes of B. vulgaris and one genome of wild beets. From 308 hybrid seedlings, 30 seedlings survived and developed on their own roots. The rest were nonviable and died in the seedling stage. Chromosome number in all viable plants equalled 27.

Triploid matings were less viable than the tetraploid matings grown in 1958. From 30 triploid matings none were viable (i.e. contained many viable plants) like those observed in tetraploid hybrids. But many matings were low in viability, which means that a few seedlings were viable in many matings (Table 1).

Table 1 - Viability of hybrids in triploid matings

Female parent	Number of matings	Number of hybrid seedlings	Number of viable progenies	Number of progenies of low viability: Containing seedlings which survived	Number of progenies of low viability: Containing plants reaching flowering stage
4n sugar beets	5	62	--	1	--
4n Swiss chard	25	246	--	15	6
Total	30	308	—	16	6

A large number of progenies low in viability was typical of triploid hybrid matings, but in many progenies some viable seedlings could be selected. Diploid and tetraploid matings in 1958 were for the most part either lethal or viable, and

only a few matings low in viability were observed among them. From 30 surviving triploid plants only 10 reached the flowering stage. Some lethal triploid hybrids were grafted and a total population of 30 triploid hybrid plants was obtained.

The degree of fertility of F_1 interspecific hybrids could not be determined in 1958 because of insufficient pollination. In 1959 the hybrids received a sufficient supply of pollen. The diploid hybrids remained as before, completely or almost completely sterile. Among about 70 diploid plants, two plants set seed (6 seeds set on one plant and 2 seeds on another). Triploid and tetraploid hybrids were semi-fertile; they produced a certain quantity of seed varying in different plants from 15 to several hundred. No plant among triploid and tetraploid hybrids remained sterile. Because of continuous growth of F_1 hybrids, it is possible to obtain several hundred seeds from the majority of plants.

Some seed obtained from F_1 hybrids was planted and about 60 first-backcross hybrids were grown. In this way, triploid and tetraploid hybrids were viable and semi-fertile. Thus application of polyploidy showed the way to obtain viable and fertile hybrids.

Examination of inflorescences and fruits showed that in all hybrids (independent of the level of ploidy) the type of inflorescence was intermediate between the type of inflorescence in the section Vulgares and in the section Patellares. Inflorescence in the section Patellares is a panicle bearing umbels. Individual flowers in a flower cluster develop separately on a common peduncle. Every flower develops its own little pedicel (forming the umbel). The basal part of flowers below the sepals is visible as well as the upper part. Fruits are simple but not monogerm, because they develop in a cluster on the same peduncle.

In the multigerm beets of the section Vulgares all flowers develop also on a common peduncle. The upper part of the flower grows over the peduncle and gives the impression that each flower in a cluster is developing separately, but the lower part of the flowers below the sepals is not visible because the bases

of the ovaries of all flowers are imbedded in the tissue of the cluster (formerly the tissues of the peduncle). Therefore, fruit in the section Vulgares is compound (a seedball).

In F_1 hybrids a flower cluster consists of 3 to 4 buds; sometimes the number of buds reaches 6 or 7. Individual flowers in the flower cluster develop separately on a common peduncle like the flowers in a flower cluster of the section Patellares, but they do not develop pedicels which are typical of the section Patellares. The basal part of a flower is visible.

Fruits of F_1 hybrids are compound, consisting of 2 or 3 fruits, but they do not form a seedball. The basal part of individual fruits is connected by the tissue of the peduncle, but it is not imbedded in it. The basal part of individual fruits is oval or elongated, resembling to some extent the shape of the fruit of B. patellaris. The sepals extend over the fruit, always covering the cap. The sepals are fleshy and the cap is expressed as in the section Vulgares. Fruits of F_1 hybrids appear as if composed of fruits of both species, the lower part belonging to B. patellaris, the upper part to B. vulgaris.

INFLORESCENCES AND FLOWERS OF B. PATELLARIS, B. VULGARIS AND F_1 HYBRID

Figure 1. Inflorescence of B. patellaris

Figure 2. Inflorescence and shape of flower of B. patellaris

Figure 3. Inflorescence of B. vulgaris

Figure 4. Shape of flower of B. vulgaris

Figure 5. Inflorescence of F_1 4n hybrid (B. vulgaris X B. patellaris)

Figure 6. Shape of flower of 4n hybrid (B. vulgaris X B. patellaris)

FRUITS OF BETA VULGARIS, F_1 HYBRID AND BETA PATELLARIS

A B C

Figure 7. (A) Seed of B. vulgaris, (B) F_1 4n hybrid (B. vulgaris X B. patellaris), and (C) B. patellaris

Figure 8. Fruit of F_1 4n hybrid (B. vulgaris X B. patellaris)

MEIOSIS IN THE FIRST BACKCROSS HYBRIDS BETWEEN TURKISH LEAF BEET AND *BETA PROCUMBENS*

By Helen Savitsky

Meiosis was studied in triploid first backcross hybrids (F_1 (B.v. X B.p.) X B.v.) obtained from R. K. Oldemeyer. These triploid hybrids originated from non-reduced gametes of F_1 hybrids fertilized by the gametes of diploid *B. vulgaris*. Therefore, they contained 18 chromosomes of *B. vulgaris* and 9 chromosomes of *B. procumbens*.

At diakinesis, bivalents, univalents, as well as trivalents and tetravalents, were observed. The number of bivalents varied in different pollen mother cells from 5 to 10, the number of univalents from 3 to 9. Trivalents were present in all pollen cells. In about 50 percent of pollen mother cells tetravalents were observed. Some pollen mother cells contained either two trivalents or one trivalent and one tetravalent. In this way, formation of complexes was typical for the triploid hybrids.

Trivalents were presented in the shape of rods, chains, Y-type associations, or rings. They originated either from association of 2 homologous chromosomes of *B. vulgaris* with a homologous end of a *B. procumbens* chromosome, or by association of 2 homologous chromosomes of *B. vulgaris* (one of which carried a translocated segment from a chromosome of *B. procumbens*) with a translocated chromosome of *B. procumbens*. These three chromosomes, one normal and one translocated *B. vulgaris* chromosome, together with a translocated *B. procumbens* chromosome, produced a trivalent association. A closed ring of three could originate only in the case where one of the three chromosomes involved in association was segmentally changed and both its ends were identical.

Tetravalents were observed in the shape of rods, chains, figures of eight, and rings. They might arise: 1) from association of 2 bivalents connected by a chiasma at the 2 homologous ends, or 2) from association of 2 homologous

chromosomes of *B. vulgaris* (one of which was translocated) with a translocated chromosome of *B. procumbens.* These three chromosomes could be connected by a chiasma with a homologous segment of a fourth chromosome from either *B.vulgaris* or *B. procumbens.*

It may be assumed that 18 homologous chromosomes of *B. vulgaris* associated preferably with each other, forming 9 bivalents. But an excess of bivalents in several pollen mother cells ($1_{1111} + 10_{11} + 3_{1}$) indicated that some *B. vulgaris* chromosomes even in the presence of their homologues associated with the chromosomes of *B. procumbens.* This kind of association could be stimulated to some extent by translocations between chromosomes of *B. vulgaris* and chromosomes of *B. procumbens.*

Heterobivalents were observed in several cells. Two kinds of heterobivalents were found -- bivalents with terminal deficiencies and bivalents with an additional segment translocated to one of the partners of the bivalent. In this way, triploid backcross hybrids showed structural chromosome changes.

The number of chromosomes in the nuclei at interkinesis varied from 8 to 18. Most frequently observed were nuclei with 12, 13 and 14 chromosomes. Number of chromosomes in the nuclei of tetrads varied from 8 to 18. The majority of nuclei (gametes) carried 10, 11 and 12 chromosomes.

Triploid first backcross hybrids pollinated by diploid sugar beets produced second backcross progeny with 18, 19, 20 and 37 chromosomes. The prevailing majority of plants in this generation were diploids; about one-fifth of the offspring were heteroploids.

Because of segmental interchanges which occurred in meiosis of triploid hybrids, these hybrids represent a source of structural and numerical changes, and it is possible to expect the appearance of nematode-resistant plants among their offspring.

STUDY OF SUCROSE AND YIELD IN TETRAPLOID AND DIPLOID MONOGERM AND MULTIGERM POPULATIONS

By V. F. Savitsky

INTRODUCTION

Inheritance in polyploids is characterized by several peculiarities which are absent in diploid organisms. It concerns the type of segregation, also a reaction toward different types of mating. Haldane, J. B. S., Mather, K., Fisher, R. A.; Wright, S., Kempthorne, O., have worked out a mathematical basis for segregation in tetraploids, but in most crop plants the processes of variability in polyploids have not been studied experimentally.

For study of variability of sucrose and weight of root in tetraploid sugar beets, experimental hybrid populations between monogerm and multigerm beets were developed. These populations differed in their origin and in the type of mating applied during their propagation.

Self-sterile experimental populations studied in this experiment represent typical tetraploid sugar beet populations, but they differ from the usual populations in that the "genetic conditions" involved in their formation had been predestinated and were controlled from the beginning of their development. Therefore, it was possible to study processes of variability in polyploids with these populations under different types of matings: hybridization, open-pollination, sibbing, and selfing.

Self-fertile tetraploid inbreds and populations have not been developed and studied until now.

MATERIALS AND METHODS

The experiment included the following tetraploid populations which were obtained by H. Savitsky by using colchicine treatment:

4n US 35/2 multigerm self-sterile

4n SLC 15 monogerm self-sterile

4n SLC 31 monogerm self-sterile

4n SLC 91 monogerm self-fertile inbred

4n Male-sterile equivalent to SLC 91 monogerm

The following diploids were used:

2n SLC 91 monogerm self-fertile inbred

2n F_2 S_1 population from hybridization of self-fertile SLC 91 mm to US 35/2 MM (Table 1)

The following generations of tetraploid hybrids were obtained by hybridization of the above-mentioned populations:

F_1, F_2 (sib), b_1 and b_2 between 4n self-sterile SLC 31 and 4n self-sterile MM US 35/2

F_2 (sib) and b_1 between 4n self-sterile monogerm SLC 31 and 4n self-sterile multigerm US 22/3

F_1, F_2 (selfed F_1) and b_1 between 4n self-fertile monogerm SLC 91 and 4n self-sterile multigerm US 35/2.

To obtain F_1 hybrids, from 20 to 30 plants in a corresponding monogerm population were pollinated (by exchanging pollinating bags) by the pollen of the same number of plants taken at random in a multigerm population. The authenticity of F_1 hybrids was controlled by the type of fruit. During production of all following generations and backcrosses, conditions providing for random reproduction were always observed. In all backcrosses within self-sterile beets, F_1 hybrids were used as female parents. In sib-crosses, two sister plants from the same F_1 family were crossed, and in selfing, a plant was self-pollinated by bagging. In self-fertile beets, tetraploid male-sterile plants equivalent to the tetraploid monogerm SLC 91 were used for female parentage to obtain F_1 seed used only for testing of the F_1 hybrids SLC 91 X US 35/2.

A test of tetraploid F_1 hybrids between monogerm male-sterile SLC 91 and US 35/2 and monogerm self-sterile SLC 31 X US 35/2 was conducted under the numbers 17-1 and 17-2 (Table 1). Every one of these hybrids was planted in 20 repetitions, each of which occupied one row on a two-row plot (entry number 17-1 and 17-2). Both of these hybrids were very close in sugar and in yield. For analysis of variance both rows of entry number 17 were calculated as all other entries which had two-row plots. Mean percent sucrose and mean weight of root for each of the

mentioned F_1 hybrids were given on the basis of analysis of 20 one-row plots.

All of the basic parental or hybrid populations, for instance, the F_1 4n SLC 91 X 4n US 35/2, were grown for seed in isolation plots. To control the chromosome deviations which might be possible in tetraploids, in every tetraploid population the plants were harvested separately and their progenies were planted individually in separate plots. In this way if any one progeny exhibited chromosome disturbances it would always be localized and could not contaminate the whole population. Cases with noticeable chromosome disturbances were not observed in this experiment.

Because seed of individual plants were tested separately, variability in different replications within a population was caused by environment and by a sampling variation of progenies composing a given population. Therefore, the number of replications for each population was increased to 20. Some populations (2n and 4n inbred SLC 91, 4n self-sterile monogerm SLC 31, 4n US 35/2, triploid hybrid) were planted in 20 replications with seed from the same sample.

Experimental Design and Analysis of Variance for Mean Weight of Root and Sucrose Percentage

Degrees of freedom, sum of squares and sources of variation in analysis of variance for mean weight of root (in pounds) and for percent sucrose are shown in Table 2.

Twenty populations were planted in two-row plots which were doubly grouped into 20 replicates (Latin square design). In every plot 50 plants were expected. In every population or block 1,000 plants (20 X 50). The total of 20,000 plants was expected in the experiment. In fact, 19,452 plants were harvested.

Mean percent sucrose for each plot was calculated from two samples containing 14 beets each. Mean weight of root for every plot was estimated by dividing weight of root from the whole plot by the number of plants in this plot.

Table 2 shows highly significant differences for populations in both characters, because the F ratio for percent sucrose equalled 10.7 and for weight of root 11.9; i.e., this ratio was larger than the corresponding F value at the 1-percent point

seed F_1 hybrid [illegible] [illegible] on the [illegible] analysis of 20 one-row plots.

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[illegible]

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Design and Analysis of [illegible]

[illegible] [illegible] Sucrose Percentage

Degrees of inbreeding [illegible] and sources of variation [illegible] lysis of variance [illegible] [illegible] of roots (in pounds) and for sucrose content are shown in Table 2.

Each population [illegible] planted in two-row plots which were [illegible] into 20 [illegible] (Latin square design). In every plot 50 plants were expected. Any population of 1,000 plants (20 X 50). The total of 20,000 plants expected in [illegible] [illegible]. In fact, 19,652 [illegible] were harvested.

[illegible] was calculated from [illegible] samples consisting

[illegible] every plot was estimated by dividing

[illegible] the number of [illegible]

The F ratio between rows was small and not significant.

The F ratio between columns was only one-third as large as the corresponding ratio for populations but was still significant and equalled 3.1 for the weight of root and 5.6 for sucrose percent.

EXPERIMENTAL RESULTS

Percent Sucrose and Yield of Hybrids Between the Tetraploid Monogerm self-sterile Population SLC 31 and Tetraploid US 35/2.

A. Mean weight of root

F_1 generation. Heterosis in tetraploids obtained by hybridization of populations

The tetraploid US 35/2 showed a higher mean weight of root (2.8830 lbs.) than the monogerm tetraploid SLC 31 (2.4860 lbs.). The difference in yield between these two populations (0.3970 lbs.) is significant at the 5-percent level of probability (Table 3).

The average weight of root of the F_1 hybrid between these two populations equalled 3.1235 lbs. The F_1 hybrid exceeded the monogerm parental population by 0.6375 lbs., with significance at the 1-percent level, and the multigerm population US 35/2 by 0.2405 lbs., which is not a significant difference.

The calculated mean weight of root of the F_1 hybrid (taken as $\frac{P_1 + P_2}{2}$) is:

$$\frac{2.4860 + 2.8830}{2} = 2.6845 \text{ lbs.}$$

This value is 0.4390 lbs. lower than that obtained in the experimental test. In this way heterosis was observed not only by hybridization of diploids, but also by hybridization of tetraploid sugar-beet populations.

F_2 generation, effect of sibbing on weight of root in tetraploid hybrids

The observed mean weight of root in F_2 hybrids obtained by sib-mating equalled 2.9240 lbs. (Table 3). This yield almost equalled the theoretical calculations according to the formula $\frac{P_1 + P_2 + 2F_1}{4} = 2.9040$ lbs. This formula is used for calculation of a theoretical mean in F_2 diploid organisms by the additive type reaction of genes. Absence of divergence between expected and

observed value of weight of root is caused by the fact that weight of root in F_2 tetraploid hybrids (2.9240 lbs.) differed only slightly from the weight of root in F_1 tetraploid hybrids (3.1235 lbs.). According to Haldane, during the process of segregation in tetraploids the degree of heterozygosity decreases more slowly than in segregation of diploids. Therefore, the effect of heterosis observed in F_1 tetraploid hybrids was maintained at a higher level in the tetraploid F_2 population than it usually was in corresponding diploid hybrids. Weight of root for such diploid hybrids calculated according to the formula $\frac{P_1+P_2+2F_1}{4}$ was higher than the observed weight of root in the F_2 generation. The effect of heterosis in diploid beets is conditioned by genes which usually do not show an additive type of reaction. In tetraploids this reaction of genes is not "fixed" by sib-mating, because of the slow decrease in heterozygosity. The inbreeding effect caused by sib-mating did not appreciably influence the yield of the F_2 population. This was confirmed also by the fact that the open-pollinated F_2 hybrids produced even a slightly lower yield than the F_2 sib hybrids (difference between both F_2 populations was not significant).

Because of the slow segregation process (slow accumulation of homozygotes) in tetraploids, the mean yield of the F_2 sib crosses exceeded the mean yield of the monogerm population SLC 31 by 0.4380 lbs. with a significance of 0.01 and did not differ significantly from the second higher yielding parental population US 35/2 (Table 3). Neither did it differ significantly in yield from the F_1 hybrid.

Backcross Hybrids

Hybridization of F_1 hybrids with both parents produced two backcross populations differing significantly from each other (Table 3).

MEAN WEIGHT OF ROOT IN POUNDS

Backcross populations	Observed	Expected according to formula $\frac{P_1+F_1}{2}$, or $\frac{P_2+F_1}{2}$	Difference
F_1 X monogerm, P_1 SLC 31 population	2.6370	2.80475	0.16775
F_1 X US 35/2, P_2	3.0060	3.0035	0.00275
Difference	0.3690	0.2985	---

The backcross hybrid (F_1 X US 35/2) did not differ significantly in weight of root from the mean root weight of the F_2 -- sib (2.9240 lbs.) or from the F_1 (3.1235 lbs.) or from the parental population US 35/2 (2.8830 lbs.). At the same time the root weight of this backcross hybrid significantly exceeded (at the 1% point) the yield of monogerm SLC 31 parent (difference equalled 0.5200 lbs.) (Table 3).

In this way tetraploids differed from diploids by slow segregation (smaller differences between F_1 and F_2 hybrids) but they changed drastically after hybridization with the different parents.

B. PERCENT SUCROSE

F_1 and F_2 (sib) generations

The tetraploid self-sterile monogerm population SLC 31 was higher in sugar than the tetraploid US 35/2. The difference in sucrose between these two populations equals 1.1700 percent. This difference is highly significant, (1% point = 0.6897, Table 3).

Percent sucrose in F_1 hybrids was 12.9450 which differs only slightly from the mean percent sucrose of the parents 13.1200.

In F_2 hybrids obtained by sib-mating percent sucrose was a little higher and equalled 13.3700. However, the difference between percent sucrose in F_1 and F_2 hybrids (0.4250) does not reach the 1% point of significance (0.5238).

Percent Sucrose

Generation	Experimental	Calculated	Difference between experimental and calculated values
F_1	12.9450	$\frac{P_1 + P_2}{2} = 13.1200$	-0.1800
F_2 sib	13.3700	$\frac{P_1 + P_2 + 2F_1}{4} = 13.0325$	+0.3375
F_2 sib	13.3700	$\frac{b_1 + b_2}{2} = 13.0600$	+0.3100
Difference between F_1 and F_2	0.4250		

Backcross hybrids

Recurrent hybridization of F_1 hybrids to monogerm population SLC 31 increased percent sucrose in the hybrids (Table 3). This backcross population with 13.5550 percent sucrose exceeded by 0.9900 percent (1% point = 0.6897) the other backcross population F_1 X US 35/2,because of the lower sugar in the parent US 35/2

Percent Sucrose in Backcross Hybrids

Population	Observed	Calculated $\frac{P_1 + F_1}{2}$	Difference between observed and expected values
F_1 X Monogerm SLC 31	13.5550	13.3250	+0.2300
F_1 X Multigerm US 35/2	12.5650	12.7400	-0.1750
Difference	0.9900	0.5850	

In contrast with comparatively little change in percent sucrose and weight of root caused by segregation in tetraploids, the effect of backcrossing to different parents appeared to be noticeable.

Self-sterile F_2 Hybrids Between Monogerm Population SLC 31 and Multigerm Population US 22/3

The tetraploid population US 22/3 was lower in percent sucrose than the tetraploid population US 35/2. All F_2 hybrids and backcrosses with the monogerm

population SLC 31 and US 22/3 were lower in sucrose than the corresponding F_2 and backcross hybrids between the same monogerm population SLC 31 and US 35/2 (Table 5). These differences for F_2 sib are significant at the 1% level.

Percent sucrose and Weight of Root in Hybrids Between the Tetraploid Self-fertile Monogerm Inbred SLC 91 and the tetraploid US 35/2.

A. MEAN WEIGHT OF ROOT

F_1 generation, Heterosis in tetraploid male-sterile monogerm hybrids

The weight of root in SLC 91 monogerm was 1.9215 lbs. Weight of root in US 35/2 was 2.8830 lbs. The difference between these two tetraploid strains was significant at the 1% level (0.9615 lbs. Table 4).

Weight of root in F_1 hybrids between these tetraploids was 3.2135 lbs. This tetraploid F_1 male-sterile hybrid exceeded both parents significantly because lsd = 0.3066, msd = 0.4057 lbs. and the observed difference between F_1 and parents equalled 1.2920 and 0.3335.

Root Weight

Generation	Mean root weight in pounds	Difference between F_1 hybrids and parents
F_1	3.2135 (observed)	--
P_1	1.9215 (observed)	1.2920
P_2	2.8830 (observed)	0.3305
$\frac{P_1 + P_2}{2}$	2.4022 (calculated)	0.8112

Heterosis in root weight was observed by hybridization of two tetraploids.

F_2 generation. Effect of selfing in tetraploid hybrids between monogerm SLC 91 and US 35/2

Mean root weight in the F_2 (S_1) hybrids derived from selfing of F_1 plants was 2.5435 lbs. (Table 4). In self-sterile F_2 hybrids derived from sibbing, the decrease in root weight when compared to F_1 hybrids was not statistically significant. (Table 3). In selfed tetraploid F_2 hybrids (SLC 91 X US 35/2) the decrease in weight of root was significant.

Root Weight

Generation	Mean root weight pounds	Difference in comparison with F_2 (S_1).
4n - F_1	3.2135 (observed)	0.6700 (sig. 1% level)
4n - F_2 (S_1)	2.5435 (observed)	--
4n - $\frac{P_1 + P_2 + 2F_1}{4}$	2.8079 (calculated)	0.2644 (not significant)
4n - F_2 Open pollinated	2.6155 (observed	0.0720 do.
2n - S_1	1.9835 (observed)	0.5600 (sig. 1% level)
4n - F_2 (sib)	2.9240 (observed)	0.3805 (sig. 5% level)
4n - Backcross F_1 X P_1	2.0435 (observed)	0.5000 (sig. 1% level)

A highly significant difference in root weight between 4n, F_2 S_1 and 4n F_1 was observed (0.6700). The difference in yield between 4n, F_2 S_1 hybrids derived from selfing and 4n F_2 hybrids derived from sibbing was also significant (0.3805 lbs.). These data indicate that selfing decreases weight of root in a higher degree than sib mating. But this decrease occurred in tetraploids in a smaller degree than in corresponding diploid hybrids. In the backcross of a tetraploid F_1 hybrid with an inbred line,homozygosity is growing faster than it occurs as a result of segregation in an S_1 tetraploid. Therefore, when F_1 hybrids were crossed back to the monogerm inbred line SLC 91 the decrease in yield was higher than in the S_1 generation. In a population obtained after such a backcross,the mean root weight was 0.5000 lbs. lower than in S_1 and 1.1700 lbs. lower than in F_1. Delayed

depression in root weight in S_1 tetraploids is conditioned by a delay in accumulation of homozygotes in selfed tetraploids as compared to diploids. Phenotypical expression of certain homozygous alleles in tetraploid beets can be even larger than the same effect in diploid beets.

B. PERCENT SUCROSE

F_1 generation. Tetraploid monogerm male-sterile SLC 91 X tetraploid US 35/2

The tetraploid monogerm inbred SLC 91 is higher in sugar than the tetraploid US 35/2. The difference in percent sucrose between these two strains was 1.4950 percent and is highly significant (Table 4).

The calculated mean sucrose for both parents $\frac{(P_1 + P_2)}{2}$ was 1.3283 percent. The percent sucrose actually observed in F_1 hybrids was a little lower than the calculated figure (13.0400 percent). The difference between the two means was 0.2425 percent and was not significant.

Percent Sucrose

Generation	Percent sucrose	Difference between sucrose observed in F_1 and parents
P - monogerm (observed)	14.0300	0.9900
P - US 35/2 (observed)	12.5350	0.5050
F_1 - observed	13.0400	--
$F_1 - \frac{P_1 + P_2}{2}$ (calculated)	13.2825	0.2425
Significant difference:		
0.05		0.5238
0.01		0.6897

F_2 (S_1) hybrids

Sucrose observed in F_2 (S_1), obtained by selfing, was somewhat higher when compared with the F_1 generation, (0.155 percent) but was not significant. Quite another situation was observed when F_1 hybrids were crossed back to the monogerm inbred line SLC 91 (Table 4); the backcross hybrids showed 14.9100 percent sucrose and differed significantly from F_1 and F_2 hybrids. This is shown in the following table:

Percent Sucrose

Generation	Percent sucrose	Observed differences in sucrose percent between backcross hybrids and other hybrid generations and parents
F_2 (S_1)	13.1950	1.8150
b_1 (F_1 X SLC 91 mm)	14.9100	---
F_1	13.0400	1.8700
F_2 sib	13.3700	1.5400
b_1 (self-sterile)	13.5500	1.3600
b_2 (self-sterile)	12.5650	2.3450
P - SLC 91 mm inbred	14.0300	0.8800
P - US 35/2	12.5350	2.3750

Tetraploid backcross hybrids from recurrent crosses.to the monogerm inbred line SLC 91 showed the highest percent sucrose (14.9100) in this experiment. Next highest in sucrose population was a diploid S_1 hybrid, (14.3750 percent). The difference between sucrose of diploid and tetraploid populations was significant at the 5% level (0.5350 percent). In this way, by the application of hybridization and selection in the later generations of hybrids, it is possible to obtain high sugar tetraploid lines of sugar beets. It may be expected that tetraploid self-fertile lines will increase sucrose percent in S_2- S_4 generations and that selection for sugar among them will produce new high-sugar lines.

Sucrose in monogerm tetraploid beets obtained by colchicine treatment

Two monogerm tetraploid strains obtained from colchicine treatment have been studied in this experiment. One was monogerm self-fertile inbred line SLC 91; the other, self-sterile monogerm population SLC 15. Both these monogerm tetraploids showed high sucrose content equal to the percent sucrose in their diploid ancestors.

Monogerm beets	Diploid		Tetraploid		Remarks
	Weight pounds	sucrose percent	weight pounds	sucrose percent	
SLC 15 monogerm self-sterile	2.7420	13.7400	3.0790	13.6700*	*Early maturing progenies
			2.7640	13.7900**	**Late maturing progenies
SLC 91 monogerm self-fertile inbred	2.1030	13.9550	1.9215	14.0300	

In both monogerm strains colchicine induced tetraploids did not differ from their original diploid strains either in percent sucrose or in root weight. Therefore, alteration in percent sucrose or in root weight does not always follow conversion of a diploid line into a tetraploid. On the other hand, some other characters (as size of seed in tetraploid beets, or resistance to curly-top) are always altered when a diploid becomes a tetraploid. However, as was shown by using hybridization, inbreeding, and selection, percent sucrose and root weight can be changed in the tetraploids. Tetraploids developed by application of these methods may differ from the fresh tetraploids obtained by colchicine treatment.

Triploid Hybrids

The monogerm triploid male-sterile hybrid studied in this experiment was derived from hybridization of the diploid male-sterile monogerm SLC 91 with tetraploid pollinator US 35/2. This triploid had the highest root weight in the experiment (3.2180 lbs.) and also had a high percent sucrose (13.4850) (Table 4). The monogerm triploid produced a significantly higher yield than the higher yielding parent US 35/2 (difference of mean 0.3350 lbs.) and showed at the same time a significantly higher percent sucrose (difference of mean 0.9500 percent).

The monogerm tetraploid F_1 hybrid, SLC 4n MS 91 X 4n US 35/2, produced a good yield and a slight increase in percent sucrose which was not statistically significant. The monogerm triploid hybrid showed the highest gross sugar per root in the experiment (0.4340 lbs.). The tetraploid F_1 hybrid between SLC 4n MS monogerm 91 and US 35/2 produced 0.4190 lbs. sugar per root. The original diploid inbred SLC 91 produced 0.2935 lbs. gross sugar per root, and the higher-in-yield tetraploid population US 35/2 produced 0.3614 lbs.

In this test, for the same gene pool, the triploid level favored, in these beets, the expression of the polygenic balance of sucrose and root weight better than in corresponding diploid and tetraploid strains.

Table 1--Origin of populations and code number of entries

CODE NUMBER OF ENTRIES	POPULATIONS	NUMBER OF CHROMOSOMES	SYMBOLS
	SERIES A - Tetraploid hybrids between self-sterile monogerm SLC 31 and US 35/2		
18	4n: Population of monogerm self-sterile tetraploid SLC 31	36	P_1
19	4n: Population of tetraploid US 35/2	36	P_2
17-2	4n: F_1 hybrids between monogerm SLC 31 and US 35/2	36	F_1
4	4n: Sib F_2 progenies between monogerm SLC 31 and US 35/2	36	F_2 Sib (US 35/2)
5	4n: Open-pollinated F_2 progenies between monogerm SLC 31 and US 35/2	36	F_2 Open-pollinated
6	4n: Backcross F_1 to monogerm parent SLC 31	36	F_1 to P_1
7	4n: Backcross F_1 to US 35/2	36	F_1 to P_2
	SERIES B - Hybrids between self-fertile inbred line SLC 91 monogerm and US 35/2		
16	4n: Tetraploid inbred SLC 91 monogerm	36	P_3
17-1	4n: Tetraploid F_1 MS monogerm hybrid SLC 91 X US 35/2	36	MS F_1
11	4n: Selfed S_1 tetraploid hybrid progenies (F_2) between monogerm SLC 91 and US 35/2	36	F_2 91 selfed
12	4n: Open-pollinated F_2 progenies between monogerm SLC 91 and US 35/2	36	F_2 91 open-pollinated
13	4n: Backcross F_1 to monogerm parent SLC 91	36	F_1 to P_3
15	2n: Diploid inbred SLC 91 monogerm	18	Diploid inbred
14	2n: Selfed S_1 diploid hybrid progenies between diploid SLC 91 and diploid US 35/2	18	Diploid S_1
20	3n: Triploid monogerm hybrid between diploid MS monogerm SLC 91 and tetraploid US 35/2	27	MS triploid
	SERIES C - Tetraploid hybrids between self-sterile monogerm 31 and US 22/3		
8	4n: Sib F_2 progenies between monogerm SLC 31 and US 22/3	36	F_2 Sib (US 22/3)
9	4n: Open-pollinated F_2 progenies between monogerm SLC 31 and US 22/3	36	F_2 US 22/3 open-poll.
10	4n: Backcross progenies F_1 to P_1	36	F_1 US 22/3 to P_1
	SERIES D - Diploid and tetraploid populations originating from SLC 15 self-sterile monogerm		
1	2n: Open-pollinated progenies from diploid SLC 15 monogerm	18	Diploid 15
2	4n: Open-pollinated progenies from tetraploid SLC 15 monogerm	36	Tetraploid 15
3	4n: Open-pollinated progenies from tetraploid SLC 15 monogerm	36	Tetraploid 15

Table 2--Mean squares, degrees of freedom and sources of variation in analysis of variance for mean weight of roots in pounds and for percent sucrose.

Sources of variation	Degrees of freedom	Mean root weight in pounds			Percent sucrose		
		Sum of squares	Mean squares	Variance ratio F	Sum of squares	Mean squares	Variance ratio F
Total	399	161.0760			489.3644		
Between columns	19	14.3485	0.7552	3.1078	76.0479	4.0025	5.6448
Between rows	19	8.5805	0.4516	1.8584	26.0929	1.9368	0.8320
Between populations	19	55.0363	2.8966	11.9202	144.7259	7.6172	10.7425
Residual	342	83.1107	0.2430	---	242.4977	0.7091	---

Table 3--Tetraploid hybrids between self-sterile monogerm beets and US 35/2

Code number of entries	Populations	Mean root weight	Mean sucrose
		Pounds	Percent
18	4n: Monogerm self-sterile 31-P_1	2.4860	13.7050
19	4n: US 35/2 - P_2	2.8830	12.5350
17-2	4n: $F_1 = P_1 \times P_2$	3.1235	12.9450
4	4n: F_2 Sib	2.9240	13.3700
5	4n: F_2 open-pollinated	2.7995	13.3950
6	4n: Backcross F_1 to P_1	2.6370	13.5550
7	4n: Backcross F_1 to P_2	3.0060	12.5650
lsd at 5% point		0.3066	0.5238
msd at 1% point		0.4037	0.6897

Table 4--Hybrids between self-fertile monogerm inbred line SLC 91 monogerm and US 35/2

Code number of entries	Populations	Mean root weight	Mean sucrose
		Pounds	Percent
	A. Tetraploid beets		
16	4n:Inbred SLC 91 monogerm - P_3	1.9215	14.0300
19	4n: US 35/2 - P_2	2.8830	12.5350
17-1	4n: $F_1 = P_3 \times P_2$	3.2135	13.0400
11	4n: F_2 selfed (S_1)	2.5435	13.1950
12	4n: F_2 open-pollinated	2.6155	13.6550
13	4n: Backcross F_1 to P_3	2.0435	14.9100
	B. Diploid beets		
15	2n: Inbred SLC 91 monogerm	2.1030	13.9550
14	2n: SLC 91 mm X US 35/2 selfed (S_1)	1.9835	14.3750
	C. Triploid beets		
20	3n: 2n MS SLC 91 mm X 4n US 35/2	3.2180	13.4850
lsd at 5% point		0.3066	0.5238
msd at 1% point		0.4037	0.6897

Table 5--Tetraploid hybrids between self-sterile monogerm beets SLC 31 and US 22/3

Code number of entries	Populations	Mean root weight	Mean sucrose
		Pounds	Percent
18	4n: Monogerm self-sterile 31 - P_1	2.4860	13.7050
8	4n: F_2 P_1 X US 22/3-Sib	2.5205	12.6100
9	4n: F_2 P_1 X US 22/3 open-pollinated	2.5755	12.6050
10	4n: Backcross F_1 to P_1	2.6375	13.5200
lsd at 5% point		0.3066	0.5238
msd at 1% point		0.4037	0.6897

Table 6--Diploid and colchicine-induced tetraploid populations originated from SLC 15 mm (self-sterile beets)

Code number of entries	Populations	Mean root weight	Mean sucrose
		Pounds	Percent
1	2n: Diploid SLC 15 monogerm	2.7420	13.7400
2	4n: Tetraploid SLC 15 monogerm (From early maturing progenies)	3.0790	13.6700
3	4n: Tetraploid SLC 15 monogerm (From late maturing progenies)	2.7640	13.7900
lsd at 5% point		0.3066	0.5238
msd at 1% point		0.4037	0.6897

PART IV

BREEDING FOR NEMATODE RESISTANCE

and

SCREENING TESTS IN FIELD AND GREENHOUSE

Foundation Projects 13 and 23

Charles Price C. H. Smith

and

Cooperators in Nematology Section

PROJECT 13

BREEDING FOR RESISTANCE TO SUGAR BEET NEMATODE

Charles Price

There are few sugar beets which have even moderate tolerance to Heterodera schachtii. Out of the many thousands of sugar beets screened in the greenhouse at Salinas, very few have shown tolerance, and most of these are eliminated when subjected to the more rigorous tests. The problem is further complicated by the special requirements for beets planted in the various areas in which sugar beet nematode is a problem. In the breeding program aimed at the development of a nematode resistant variety, attempts are being made to combine resistance in various selected lines and to incorporate in sugar beets the high degrees of resistance found in wild species. At Salinas, interspecific hybrids between B. vulgaris and B. webbiana have been made, and to bridge the lethal hybrids, the seedlings are grafted on sugar beets. Dr. Helen Savitsky has suggested that by obtaining polyploid hybrids it will be easier to overcome the barrier of sterility than is possible with diploid hybrids, and that it is probable that the transmission of genes responsible for nematode resistance will be more successful in polyploids than in diploids.

Screening tests of new material and material from the second cycle of breeding was continued at Salinas, California, in 1959. Screening tests are facilitated by the use of a special greenhouse technique developed and used at the Research Station in an effort to develop varieties of beets resistant to sugar beet nematode. It involves the use of soil collected from fields following a crop of sugar beets which has suffered severe damage from sugar beet nematode. This soil contains a large population of newly formed cysts

and, very frequently, fungi which cause damping-off. The number of cysts in the field soil is determined by means of screens which separate the cysts from debris. The screened cysts are taken to the laboratory and counted by means of a microscope. Soil with approximately 200 cysts per 100 grams of soil is considered good for use in the greenhouse tests. In the breeding program at Salinas, thousands of plants are examined for presence of nematodes on sugar beet roots. A special soil mix with a large portion of sand is used in this work. Heavy soil is undesirable because it is difficult to wash the clay from the roots of plants, making examination of the roots for presence of nematode, difficult. To the special soil mix is added a measure volume of the cyst-laden field soil to insure a high population of nematodes. The field soil and the special soil are mixed thoroughly to insure a uniform distribution of nematodes in the soil in which the beets for screening are planted. The mixed soil is placed in a greenhouse flat and the seedling beets are transplanted approximately 2 inches apart. After approximately 8 weeks, the beets are carefully removed from the flats and the soil particles washed from the roots in such a manner that most of the nematodes remain on the roots. The beet roots are examined for the presence of nematodes, after adhering soil is removed. If the roots are relatively free from nematodes, each individual plant is transplanted to a small cylinder of infested soil for further growth. After the plants have grown in the cylinders for approximately 8 weeks, the roots are examined again for the presence of nematodes. The most resistant plants are used for breeding.

Evidence is accumulating that reduction in stand of sugar beets, both in greenhouse and field, results from combined effect of sugar beet nematode and damping-off. Beets are weakened in the early stage of growth, and frequently seedlings of susceptible beets are virtually eliminated. In the screening tests in the greenhouse at Salinas, selections have been made from beets grown in

land by means of screens which separate the cysts [illegible] seed cysts are taken to the laboratory and counted by [illegible] of a [illegible] soil with approximately 2 cysts per cc (gram of [illegible] is considered good for use in the greenhouse tests. In the breeding [illegible] grown at Salinas, however, [illegible] plants are examined for presence of nematodes [illegible] sugar beet roots. A special soil mix with a large portion of [illegible] is used in this [illegible] heavy soil it is difficult to wash the clay from the roots of plants making examination of the roots for presence of nematode difficult. To the special soil mix is added a measured volume of the cyst-infested field soil to insure a high population of nematodes. The field soil and the special soil are then thoroughly mixed to insure uniform distribution of nematodes in the soil in which the seeds [illegible] are planted. The mixed soil is placed in a greenhouse flat and the resulting seedlings are transplanted [illegible] 2 inches apart. After approximately 6 weeks the roots are carefully removed from the flats and the soil particles washed from the roots in such a manner that most of the [illegible] remain on the roots. The beet roots are examined for the [illegible] of [illegible] after [illegible] soil is removed. [illegible] the roots are [illegible] free from nematodes, each individual plant is transplanted to a [illegible] of infested soil for further growth. After the plants have grown in the [illegible] for approximately 6 weeks, the roots are examined again for the presence of [illegible]. The most resistant plants are used for breeding.

[illegible] in [illegible] cooperating [illegible] in stand of sugar beets, both in [illegible] resulting from combined effect of sugar beet nematode and [illegible] early stage of growth [illegible]

[illegible] from beets grown in

greenhouse flats under conditions of severe exposure to both nematodes and damping-off. Progeny from polycrosses of the most promising of these selections are brought into the breeding program after rigorous testing in the greenhouse and field. Some of these progenies have gone through the second cycle of breeding and reselections. Greenhouse tests with this material indicate strongly that some material shows promise of having resistance to a combination of nematodes and damping-off in the early stages of growth (Figure 1).

The second cycle of breeding material has also been tested in the field under conditions of severe exposure to nematodes and damping-off. Field tests have been of two types. One involves planting the test beets in 3-gallon crocks, and in other tests, the beets are planted in the open field. Crocks (Figure 2) are used because more certain exposure of each individual beet to nematodes is possible than in field tests. A nematode-infested field that has become infested naturally is rarely uniformly infested. Some areas in the field may be relatively free from nematodes, while other areas are badly infested. In the crocks, a definite number of nematode cysts are placed in each crock and, therefore, each beet tested is subjected to nearly the same exposure as every other beet. It is also possible to compare each strain of beets in infested and uninfested soil with assurance that the uninfested soil will not be contaminated with nematodes. Holes are bored in the bottom of the crock; the roots are prevented from blocking the holes, to insure good drainage. The crocks are partially imbedded in the soil to reduce evaporation. All soil used in the crocks is thoroughly mixed before placing in the crocks to insure uniformity in each crock. Twenty crocks are used for each replication of each variety or strain of beets planted. Ten of

the crocks contain soil to which no nematode cysts are added, and ten crocks contain the same soil, with nematode cysts added. In this way it is possible to compare each variety tested in nematode infested and uninfested soil (Figures 3, 4), with assurance that the uninfested soil will not be contaminated with nematodes.

Each of the varieties or strains of sugar beets tested are grown in infested and uninfested soil and one beet is grown in each crock. Comparisons are made between breeding material in infested and uninfested soil on the basis of vigor, wilting, freedom from rot, and other plant manifestations, as well as weight of root. US 41, a variety of beets developed by Dr. F. V. Owen for curly top resistance, is used as a check in greenhouse screening and field tests. Although US 41 has not been bred for resistance to Heterodera schachtii, there are some conditions under which it has moderate resistance to the pest. The occurrence of different races of the sugar beet nematode Heterodera schachtii could greatly affect progress of the breeding program aimed at the development of resistant varieties. In order to reduce the possibility of limiting infested soil used to one race, soil is selected from more than one grower's field. Of course, it is realized that if more than one race of Heterodera schachtii exists, it is possible that they may occur in the same field.

Experimental Results

Experimental results obtained from greenhouse and crock tests at Salinas, California, in 1959 were encouraging. These tests were with material in the second cycle of breeding. In the crock test, in which the varieties were compared in infested and uninfested soil, selections 834, 857-15, 850-6, and 832 yielded nearly as high in infested soil as in uninfested soil. Statistical analyses of the data showed no significant difference in yield

compare each variety used in nematode infested and uninfested soil (Figures 3, 4), with assurance that the uninfested soil will not become infested with nematodes.

Each of the varieties or strains of sugar beets tested ~~was~~ grown in infested and uninfested soil and one beet is grown in each crock. Comparisons are made between breeding material in infested and uninfested soil on the basis of vigor, wilting, freedom from rot, and other plant manifestations, as well as weights of roots. US 11, a variety of beets developed by Dr. E. V. Owen for curly top resistance, is used as a check in greenhouse screening and field tests. Although US 11 has not been bred for resistance to *Heterodera schachtii*, there are some conditions under which it has shown some resistance to the pest. The occurrence of different races of the sugar beet nematode *Heterodera schachtii* could very affect progress of the breeding program aimed at the development of resistant varieties. In order to reduce the possibility of limiting infested soil used to one race, soil is selected from more than one growing field. Of course, it is realized that if more than one race of *Heterodera schachtii* exists, it is possible that they may occur in the same field.

Detailed results obtained in greenhouse and crock tests and field trials in 1959 are encouraging. Many beets were high breeding material in the field plot grown in the crock test, which the tests used a tested

of roots. In US 41, used as a check, there was a significant reduction in yield resulting from nematode injury. US 41 also wilted appreciably more during warm days than some of the selections for nematode resistance, despite adequate moisture content of the soil. Some of the selections, however, were no better than US 41. On the basis of the results obtained in these tests and observations in commercial fields of sugar beets, there appears to be a wider range of variation in reaction to nematode attack in breeding stock and perhaps in commercial varieties than first appeared. In a commercial field near Salinas, the sugar beets were injured by nematode to the extent that the sugar beets in large areas of the field were largely killed in the early stages of growth. There were, however, occasional beets which made a satisfactory growth in spite of the heavy nematode population. Selections of these superior beets were made in the field and these selections will be tested for possible resistance to nematode.

In the crock tests, there was apparently segregation for nematode resistance among the beets growing in the heavily infested soil. At harvest, the most promising individual beets were selected, and these will be tested for possible resistance to nematode, and possibly used also for crossing with other promising material.

A field test at Salt Lake City, Utah, under conditions of severe nematode exposure, was conducted by Mr. C. H. Smith. In Mr. Smith's test, there were striking differences among the varieties in the reaction to nematode. Some varieties were virtually eliminated, while other varieties had relatively good stands and made favorable growth, considering the severity of the test. Mr. Smith will report on this work.

Figure 1. Greenhouse flat which contains soil heavily infested with sugar beet nematode and fungi causing damping-off. US 41 planted in middle two rows and 859 on each side. 859 is a second-generation selection of a poly-cross of several promising selections for nematode resistance. US 41 used as check is moderately resistant to nematode attack, but apparently is susceptible to a combination of nematode and damping-off.

Figure 2. General view of 3-gallon crocks in field at Salinas, California, in which sugar beets are tested for resistance to <u>Heterodera schachtii</u>.

Figure 3. US 41 planted in 3-gallon crocks in the field.
Left: Beets growing in uninfested soil.
Right: Beets growing in <u>Heterodera schachtii</u> infested soil.

Figure 4. Selection 850 planted in 3-gallon glazed crocks.
Right: Beets growing in uninfested soil.
Left: Beets growing in <u>Heterodera schachtii</u> infested soil.

VARIETY TEST UNDER SEVERE NEMATODE EXPOSURE
SALT LAKE CITY, UTAH, 1959

By C. H. Smith

INTRODUCTION

Evaluation of varieties for nematode resistance in 1959 was conducted on the [redacted] 8-acre nematode-infested field used in 1957 and 1958. The section of the field used for the 1959 test had produced [redacted] 25-ton per acre yield of sugar beets in 1958 under [redacted] soil fumigation experiment. The field is located on the Rell Swensen farm at Taylorsville, Utah.

Lines of sugar beets that had been selected for nematode resistance were obtained from the American Crystal Sugar Company; from the U.S.D.A. Research Station, Salinas, California; and Salt Lake City selected lines. Sugar beet lines unselected for nematode resistance were provided from our Salt Lake City station and by the Utah-Idaho Sugar Company.

Careful observations were made of all varieties, prior to thinning, for the presence of cysts of the nematode, <u>Heterodera schachtii</u>. Agronomic conditions were ideal for normal seedling growth but the combination of high temperatures and a high population of nematodes resulted in heavy losses of seedlings in many of the lines of beets. Although the heaviest loss of seedlings occurred during the first week after thinning, the loss continued to be high for [redacted] month after thinning.

Discussion of varieties

Characteristic foliar wilting on warm afternoons was an outward expression of nematode injury in certain lines. Wilting in some lines was so severe that whole leaves or portions thereof became brown and dry. This characteristic was particularly noticeable among the inbred lines.

Top growth on some lines selected for nematode resistance was luxuriant but the root and top relationships at harvest were disappointing. Root distortion was severe. Selection of breeding material was based on root shape and size as well as top growth appearance. Some lines that showed outstanding top vigor throughout the summer were eliminated from the selection program, because root distortion was so severe. Root weights expressed as tons per acre included small beets that were not marketable. The calculation of tare and elimination of roots normally included in the screenings would greatly reduce the tonnage figures appearing in the tables.

VARIETY TEST UNDER SEVERE NEMATODE EXPOSURE
SALT LAKE CITY, UTAH, 1959

Grower: Rell Swensen

Soil type: Welby fine sandy loam

Previous crops: 1952 alfalfa; 1953, grain; 1954, sugar beets; 1955, grain; 1956, sugar beets; 1957, sugar beets--nematode test field; 1958, sugar beets -- nematode test field.

Fertilizers and cultural practices: Applications of manure and commercial fertilizers were used. About 15 spreader loads of manure (chicken litter) and 200 pounds of ammoniated phosphate (20-40) per acre were applied and worked into the soil during seed-bed preparation.

Planted: May 22, 1959

Thinned: June 22, 1959

Irrigations: First irrigation, May 23. Total of 15 irrigations by furrow.

Harvested: October, 1959. At harvest selections were made from outstanding lines based on root shape and size as well as foliar appearance. Beets were hand topped and individual plot weights obtained. No sugar analysis was taken.

Experimental design: Each group of sugar beet lines was randomized throughout the experimental area. Effective plot length of 21 feet with 20 inches between rows. Single-row plots were used throughout the test. Objective at thinning was six to eight inches. Four-foot alleys separated the ends of each plot. Beets were left in the alleys for periodic examination during the summer but removed prior to harvest.

Each group of sugar beet lines appeared together in each replication for convenience of observation. Unselected lines were of high vigor quality under normal planting conditions.

VARIETY TEST UNDER SEVERE NEMATODE EXPOSURE
SALT LAKE CITY, UTAH, 1959

S. L. No.	1958 No.	ORIGIN		NO. reps.	TONS BEETS PER ACRE	BEETS PER 100' ROW June 29	BEETS PER 100' ROW Harvest	VIGOR June 29
			1958 Nematode Selections					
90.1	80.29	6351	Price 590-8	3	8.6	52.4	52.4	4.7
90.2	80.29	"	"	3	9.5	72.8	72.8	3.3
90.3	80.29	"	"	3	5.9	71.4	41.3	2.7
90.4	80.29	"	"	3	10.4	72.8	68.2	3.3
90.9	80.57	6353	Price 590-12	3	9.5	61.9	61.9	4.0
90.10	80.57	6353	"	3	10.8	87.1	82.5	4.0
90.11	80.57	"	"	3	11.7	89.0	74.6	3.3
90.12	80.57	"	"	3	11.5	95.2	79.3	3.7
90.13	80.57	"	"	2	5.4	73.8	71.4	4.0
90.14	80.57	"	"	2	10.4	57.1	57.1	4.5
90.15	80.57	"	"	1	5.6	76.2	76.2	5.0
90.16	80.57	"	"	2	2.3	61.9	50.0	5.5
90.27	80.66	6354	Price 592-3	3	6.8	76.2	66.6	4.3
90.28	80.66	"	"	3	9.5	72.8	72.8	4.0
90.29	80.66	"	"	3	8.1	79.5	58.7	3.7
90.30	80.66	"	"	3	13.8	72.8	72.8	4.3
90.34	80.67	"	"	1	13.1	104.7	104.7	3.0
90.35	80.75	"	"	3	7.2	67.1	61.9	5.0
90.54	8S	SP 570-02 (Stewart)		1	3.4	14.3	14.3	6.0
90.55	8S	"		3	7.3	61.9	58.7	4.0
90.64	11S	SP 57106-0 "		3	8.6	65.2	58.7	4.3
90.68	16S	SP 57110-0 "		3	9.0	71.4	66.6	4.0
90.69	16S	SP 57110-0 "		3	4.3	58.5	42.8	5.3
90.73	34-U	824 aa X sug. sel.		3	6.9	55.7	55.5	4.0
90.74	34-U	" 202		3	4.7	36.7	34.9	4.7
90.76	36-U	824 aa X U-I 114		3	8.2	50.9	50.9	4.7
90.80	39-U	824 aa X Am #2 type		3	10.0	55.7	55.7	4.0
90.85	66-U	824 aa X IMCC 5		1	3.1	33.3	19.0	6.0

VARIETY TEST UNDER SEVERE NEMATODE EXPOSURE
SALT LAKE CITY, UTAH, 1959

S.L. No.	ORIGIN		No. REPS	TONS BEETS PER ACRE	BEETS PER 100' ROW June 29	BEETS PER 100' ROW Harvest	VIGOR RATING June 29
			1957 Nematode Selections				
80.2	6316	56-407	3	11.6	98.5	80.9	2.0
80.7*	6317	56-408	3	8.2	70.0	57.1	2.3
80.10*	6318	56-409	3	15.3	89.0	66.6	4.0
80.12	6318	56-409	1	10.0	47.6	47.6	1.0
80.14	6319	56-410	3	10.0	72.8	61.9	3.7
80.15	6319	56-410	3	11.1	57.1	52.4	3.7
80.19	6320	55-410	3	6.4	74.7	57.1	3.7
80.20*	6320	"	3	12.2	85.7	73.0	2.3
80.21*	6320	"	3	12.0	65.2	65.2	3.0
80.22*	6320	"	3	12.4	80.9	66.6	2.3
80.24*	6321	56-412	3	13.6	90.4	73.0	2.3
80.35*	6351	590-8	3	10.1	76.2	71.4	3.0
80.36	6351	"	3	10.1	84.3	71.4	4.0
80.37	6351	"	3	7.9	58.5	58.5	5.0
80.38	6351	"	3	8.3	50.9	50.9	4.3
80.40	6351	"	3	9.6	68.1	50.8	4.7
80.41	6351	"	3	9.4	63.3	53.9	4.7
80.46	6352	590-9	3	8.3	57.1	57.1	4.3
80.47	6352	"	3	7.8	68.1	58.7	4.3
80.48	6352	"	1	5.6	33.3	33.3	6.0
80.49	6352	"	3	6.2	52.4	47.6	5.3
80.50	6352	"	3	4.9	46.2	28.6	4.3
80.51	6352	"	1	8.4	95.2	85.7	4.0
80.56	6353	590-12	3	3.1	46.2	36.5	5.3
80.57	6353	"	3	12.8	84.3	79.3	3.7
80.58*	6353	"	3	9.3	80.9	73.0	3.0
80.59*	6353	"	3	10.6	72.8	71.4	3.0
80.78	6354	592-3	3	8.9	90.4	73.0	3.0
80.79	747-12 X	nem.res.sel.	3	9.3	76.2	69.8	3.7
80.80	747.14 X	"	3	8.5	52.4	52.4	4.0
80.81	74717-377 X	"	3	7.1	65.2	50.8	4.0
80.82	74718-406 X	"	3	6.8	52.4	52.4	4.0

3 replications for each variety

S.L. No.	ORIGIN		TONS BEETS PER ACRE	BEETS PER 100' ROW June 29	BEETS PER 100' ROW Harvest	VIGOR RATING June 29
		Nematode resistant selections (Mass increases)				
880	Price	590-3	8.3	47.6	47.6	4.7
881	"	590-5	9.1	42.8	42.8	4.7
882	"	590-6	10.4	60.3	57.1	3.7
883	"	590-8	8.0	68.2	66.6	3.3
884	"	590-9	8.8	57.1	57.1	4.0
885	"	590-11	8.4	92.0	65.1	3.3
886	"	590-12	7.2	61.9	49.2	4.0
887	"	591-2	12.7	85.7	84.1	3.3
888*	"	591-3	10.5	100.0	74.6	3.0
889	"	592-1	11.1	88.9	61.9	3.0
890	"	592-2	15.7	82.5	82.5	3.3
891	"	592-3	9.7	80.9	63.5	3.7
892*	"	594-1	12.7	76.2	66.6	2.7
893	"	594-2	6.8	53.9	39.7	3.3
894	7267 mm [redacted] X 590-3 etc. nema. sel.		8.5	66.6	55.5	4.0

* Used for further selection

VARIETY TEST UNDER SEVERE NEMATODE EXPOSURE
SALT LAKE CITY, UTAH, 1959

CALIFORNIA CODE NO.	Number replicates	TONS BEETS PER ACRE	BEETS PER 100 ft. ROW June 29	BEETS PER 100 ft. ROW Harvest	VIGOR RATING June 29
		Charles Price Nematode-Selected Varieties			
803	1	8.1	57.1	57.1	4.0
804-1	6	7.7	62.7	57.1	4.7
804-2	5	8.8	67.6	60.0	4.0
804-3	1	3.7	42.8	33.3	5.0
828-10	5	10.0	54.3	54.3	4.0
831-1	5	13.3	90.4	77.1	3.2
832-2	6	9.7	80.9	65.8	3.3
833-1*	1	28.0	100.0	85.7	1.0
833-3*	6	13.3	92.0	38.0	2.7
834	1	7.8	38.1	57.1	4.0
850	1	12.1	76.2	66.6	3.0
851	1	3.7	33.3	28.6	5.0
850-1	6	6.4	57.1	47.6	4.2
850-6	6	7.8	76.2	51.6	4.0
851-2	6	8.6	69.8	63.5	4.5
853	1	10.6	57.1	57.1	4.0
852	1	14.3	104.7	90.4	2.0
853-1	6	10.4	68.2	58.7	4.5
853-2	6	9.9	60.3	60.3	4.0
854-1*	6	11.5	70.6	65.8	3.7
854	1	0.3	19.0	4.8	6.0
854-2*	1	12.9	75.4	65.1	3.5
854-4	5	10.3	61.9	61.9	3.8
855	1	9.6	61.9	61.9	4.0
855-3	5	11.3	76.2	71.4	3.4
856	1	2.8	28.6	28.6	4.0
856-1	6	9.6	82.5	67.4	4.5
857	1	5.9	42.8	42.8	5.0
857-1	3	6.9	76.2	55.5	4.7
857-3	6	8.8	70.6	52.4	4.0
858	1	9.0	57.1	38.1	4.0
857-4*	6	13.5	58.7	58.7	4.2
859	1	6.2	66.6	52.4	4.0
859-4	5	9.0	60.0	47.6	3.8
859-8*	5	13.4	87.6	76.2	3.8
860	1	8.1	90.4	80.9	3.0
860-3*	6	13.8	71.4	73.8	3.8
861	1	8.1	80.9	61.9	4.0
861-15	6	7.5	74.6	57.9	3.8
862	1	8.4	100.0	66.6	4.0
862-1	3	7.9	71.4	71.4	4.0
862.2	1	0	0	0	0
862-3	1	8.4	80.9	57.1	4.0
862-4	1	8.1	66.6	66.6	4.0
862-5	1	8.4	95.2	61.9	4.0
862-6	1	4.4	33.3	28.6	5.0
862-7	5	13.0	83.8	82.8	4.0
862-8	5	7.0	51.4	51.4	5.0
862-9	1	0	0	0	0
862-10	1	10.0	57.1	57.1	4.0
862-11*	1	12.8	76.2	76.2	3.0
862-12	1	5.0	42.8	42.8	4.0
862-13*	5	13.3	81.9	69.5	3.8
862-14	1	3.7	38.1	23.8	4.0
862-15*	4	12.8	83.3	83.3	3.7
863	1	6.8	76.2	61.9	4.0
869-7*	5	9.8	74.3	62.8	4.2
870-10	1	10.3	47.6	47.6	3.0
871-13	5	12.3	83.8	70.4	3.8
872-14	1	7.8	76.2	66.6	4.0
889-1	6	13.0	92.8	79.3	3.3
890-2	1	3.7	71.4	42.8	5.0
892-5	5	12.9	87.6	74.3	4.0
894-6	5	9.3	84.7	69.5	3.6
895-7	5	11.0	115.2	87.6	3.6
897-9	5	11.0	87.6	73.3	3.6
899-11*	5	14.7	68.5	68.5	3.4

* Used for further selection

VARIETY TEST UNDER SEVERE NEMATODE EXPOSURE
SALT LAKE CITY, UTAH, 1959

Six replications for each variety

S.L. No.	ORIGIN	TONS BEETS PER ACRE	BEETS PER 100' ROW June 29	BEETS PER 100' ROW Harvest	VIGOR RATING June 29
	American Crystal Sugar Company, Nematode Selected Varieties				
9351A	58-418, Low Gal. sel. 56-408	13.2	81.7	74.6	2.8
9352A	58-419, High " " 56-408	9.8	57.1	57.1	3.7
9353A*	58-604, High " " 56-410	15.3	85.7	80.9	2.2
9354A*	58-605, Low " " 56-410	12.3	85.7	72.2	2.8
9355A*	56-407-0 Low " " 52-413	9.2	86.5	73.0	3.2
9356A	SLC 117 X 56-407-0 ((610 X 91) 108 X 117 MS)) X 56-407-0	11.0	86.5	74.6	3.5

* Used for further selection

Planting Code No.	Utah-Idaho Sugar Company -- Not selected for Nematode Resistance				
U-I	110 aa X CT5	10.1	73.8	73.8	4.3
U-2	110 aa X CT9	7.2	61.1	61.1	4.2
U-3	(110 aa X CT5) X CT9	10.9	81.7	71.4	3.8
U-4	110 aa X ACSI-10	8.4	73.8	63.5	4.2
U-5	110 aa X U-I 13	7.0	68.2	60.3	4.2
U-6	110 aa X U-I 114	7.1	87.3	76.2	4.3
U-7	114 aa X CT5	7.2	104.7	92.0	3.2
U-8	824 aa X Am #2	10.5	88.1	69.0	3.7
U-9	824 aa X IMCC 5	11.5	79.3	69.0	3.5
U-10	824 aa X Sug. sel. 202	8.6	83.3	72.2	3.8
U-11	824 aa X U-I 114	11.5	77.7	73.8	3.0
U-12	824 aa X US 400	8.9	96.8	80.1	3.5
U-13	SP 5481-0	11.1	82.5	77.0	3.2
U-14	SP 54104-0	10.9	87.3	72.2	3.2
U-15	SP 5651-0	7.8	57.1	50.0	3.8
U-16	SP 571-0	9.7	65.8	54.7	3.8
U-17	SP 57102-0	9.6	63.5	55.5	3.8

VARIETY TEST UNDER SEVERE NEMATODE EXPOSURE
SALT LAKE CITY, UTAH, 1959

3 replications for each variety

S.L. No.	ORIGIN	TONS BEETS PER ACRE	BEETS PER 100' ROW June 29	BEETS PER 100' ROW Harvest	VIGOR RATING June 29
	SALT LAKE CITY UNSELECTED VARIETIES				
	Group I (Replicated at other locations--as tests IA, IB and IC)				
E 67	CT9 MS X 5-142 mm	11.6	77.7	77.7	4.0
E 792	91 MS mm X CT5	11.5	79.3	79.3	4.0
E 790	CT9 MS X CT5	7.5	79.3	65.1	4.0
A2-90	CT9	4.5	68.2	55.5	4.7
309+5	US 35 aa X Klein E	11.3	77.7	74.6	4.3
433	US 33	7.2	79.3	76.2	3.7
4324	Klein E	9.6	73.0	60.3	4.0
5070	CT7	6.2	87.3	79.3	4.7
7101	US 22 MS X CT5	12.1	71.4	71.4	4.7
6501	Monogerm SLC 131	5.3	68.2	50.8	4.7
7096	CT9A	4.1	61.9	61.9	5.0
7864	CT8 aa X sibs	5.1	60.3	60.3	4.7
8000	CT5 aa X Sibs	5.9	49.2	49.2	4.3
8101	US 22 MS X SLC 122-19 mm	3.5	46.0	31.7	5.0
8104	do. X (CT5 X CT9)	12.3	73.0	73.0	4.3
8111	MS mm X (CT5 X CT9)	9.2	71.4	69.8	5.0
8125	MS [redacted] X SLC 122-19 mm	5.9	95.2	66.6	3.7
8210	SLC (117 X 125) X 122-27 mm	4.7	65.1	65.1	4.7
8216	SLC (117 X 125) X Line 229 mm	7.3	79.3	66.6	4.3
8504	SLC 122-19 mm	3.1	66.6	55.5	5.0
8505	SLC 122-27 mm	1.5	34.9	27.0	5.0
F54-4H7	CT9 MS hyb. X Klein E hyb.	9.7	73.0	73.0	4.0
	Group II New self-fertile lines Mm hybrids				
810		5.9	46.0	42.8	4.0
811		6.0	65.1	53.9	4.0
812		7.6	69.8	68.2	3.3
815		9.7	88.9	66.6	3.3
817		8.3	66.6	66.6	3.7
850		8.5	79.3	65.1	3.0
851		8.3	76.2	69.8	3.7
852		8.3	90.4	82.5	3.7
861		3.4	31.7	31.7	4.7
864		6.7	63.5	63.5	5.0
865		7.5	74.6	65.1	4.3

VARIETY TEST UNDER SEVERE NEMATODE EXPOSURE
SALT LAKE CITY, UTAH, 1959

3 replications for each variety

S.L. No.	TONS BEETS PER ACRE	BEETS PER 100' ROW JUNE 29	BEETS PER 100' ROW Harvest	VIGOR RATING June 29
SALT LAKE CITY UNSELECTED VARIETIES				
Group III -- Monogerm mm aa X mm hybrids				
8201	4.5	55.5	46.0	4.3
8202	3.9	41.3	39.7	5.0
8205	4.4	61.9	39.7	5.0
8210	3.7	52.4	42.8	4.7
8216	5.2	63.5	49.2	4.0
8240	8.0	68.2	61.9	4.3
8241	7.3	82.5	61.9	4.0
8243	5.4	57.1	49.2	4.7
8244	6.9	73.0	50.8	4.7
8245	10.4	85.7	76.2	4.0
8249*	4.8	44.4	30.1	5.3
8254	5.4	68.2	58.7	4.7
8261	4.0	60.3	49.2	4.7
8262	3.7	69.8	49.2	4.0
8263	6.0	82.5	68.2	4.3
8265	8.1	84.1	69.8	4.3
8269	2.4	31.7	30.1	4.5
8278	2.2	31.7	28.6	5.0
8280	7.3	41.3	14.3	5.0
8286	3.1	57.1	46.0	4.7
8287	5.2	53.9	47.6	4.7
8288	4.9	47.6	44.4	4.7
8289	1.9	47.6	36.5	5.0
8290	4.6	74.6	63.5	5.0
8291	1.7	46.0	30.1	5.3
8292	2.1	53.9	41.3	5.7
8293	1.7	41.3	28.6	5.7
8294	1.3	44.4	25.4	6.0
8295	2.4	41.3	27.0	5.3
8296	0.9	39.7	28.6	6.3

* Used for further selection

[illegible] [illegible]
[illegible] [illegible]

[illegible]	[illegible]
[illegible]	[illegible]

[illegible]

VARIETY TEST UNDER SEVERE NEMATODE EXPOSURE
SALT LAKE CITY, UTAH, 1959

3 replications for each variety

S.L. No.	TONS BEETS PER ACRE	BEETS PER 100' ROW June 29	BEETS PER 100' ROW Harvest	VIGOR RATING June 29
	SALT LAKE CITY UNSELECTED VARIETIES			
	Group IV -- Old mm Lines			
8501	2.5	46.2	36.5	6.3
8502	1.6	34.9	17.5	6.3
8504	2.9	42.8	30.1	6.0
8505	1.0	19.0	19.0	6.0
8508	0.2	12.7	3.2	6.5
8509	1.3	28.6	25.4	6.3
8510	0.5	14.3	9.5	6.5
8511	1.6	31.7	23.8	5.7
8514	1.3	30.1	23.8	6.0
8527	1.1	42.8	23.8	5.7
8528	1.0	22.2	17.5	6.3
8529	2.7	58.7	34.9	5.3
8530	1.1	23.8	17.5	6.5
8532	0.7	11.1	6.3	6.3
8533	2.5	30.1	27.0	6.0
8535	2.4	34.9	34.9	6.0
8536	2.7	36.5	33.3	6.0
8537	3.5	28.6	22.2	5.3
8538	4.0	36.5	36.5	6.0
8539	2.5	38.1	34.9	6.0
8540	2.0	17.5	17.5	6.3
8541	1.1	33.3	25.4	5.3
8542	1.8	34.9	28.6	5.3
8543	2.3	28.6	22.2	6.0
8544	8.3	22.2	11.1	5.5
8545	0.4	14.3	7.9	5.5

VARIETY TEST UNDER SEVERE NEMATODE EXPOSURE
SALT LAKE CITY, UTAH, 1959

3 replications for each variety

S.L. No.	TONS BEETS PER ACRE	BEETS PER 100' ROW		VIGOR RATING
		June 29	Harvest	June 29
	SALT LAKE CITY UNSELECTED VARIETIES			
	Group IV -- New [redacted] Lines			
8604	3.8	39.7	34.9	5.0
8606	6.5	44.4	39.7	4.7
8608	2.7	28.6	20.6	5.0
8609	7.3	53.9	53.9	4.7
8611	3.1	47.6	39.7	5.3
8613	6.2	65.1	61.9	4.7
8614	2.1	46.0	34.9	4.3
8618	4.9	73.0	50.8	4.3
8621	4.8	66.6	60.3	4.7
8626	4.6	65.1	42.8	4.3
8641	4.1	65.1	50.8	4.3
8644	2.9	66.6	49.2	4.7
8645	2.6	42.8	33.3	5.3
8649	5.3	52.4	41.3	5.0
8650	7.3	76.2	71.4	4.0
8651	5.3	60.3	60.3	5.0
8659	2.6	52.4	33.3	5.3
8664	5.7	84.1	73.0	5.0
8668	7.3	76.2	66.6	4.0
8670	4.5	49.2	39.7	4.3
8672	2.4	31.7	25.4	6.0
8673	5.6	58.7	47.6	4.0
8676	5.0	69.8	60.3	3.7

VARIETY TEST UNDER SEVERE NEMATODE EXPOSURE
SALT LAKE CITY, UTAH, 1959

3 replications for each variety

S.L. No.	ORIGIN	TONS BEETS PER ACRE	BEETS PER 100' ROW June 29	BEETS PER 100' ROW Harvest	VIGOR RATING June 29
	SALT LAKE CITY UNSELECTED VARIETIES				
	Group VI -- (CT5 sublines)				
8000	CT5 aa X sibs	2.7	44.4	34.9	5.3
8011	CT5 subline	0.9	23.8	12.7	6.5
8012	"	0.9	27.0	17.5	6.3
8013	"	1.6	27.0	23.8	6.3
8014	"	1.5	38.1	36.5	6.0
8015	"	2.4	47.6	36.5	5.0
8016	"	2.0	20.6	20.6	6.0
8017	"	2.6	68.2	47.6	4.7
8018	"	1.6	42.8	20.6	4.7
8019	"	1.8	23.8	11.1	5.0
	Group VII -- Miscellaneous				
S 1	9572-1-5 F_4 (1) SLC 101 X White beet of California	3.7	23.8	14.3	4.0
S 2	9572-10-45 F_4 (1) SLC 101 X do.	1.2	4.8	4.8	4.0
	Group VIII -- Check varieties				
F54-4H1	CT9 MS Hyb.XKlein E Hyb. (12)	8.9	59.0	50.8	4.1
028	US 41 (12)	7.5	64.7	55.7	3.7
22/4*	US 22/4 (96)	6.4	59.0	51.6	4.2

* Used for further selection

Group IX -- Comparable yield data in same field with commercial monogerm variety

	Date of planting	Tons beets per acre**
Fumigated, 25 gal. per acre Shell DD	March 26	25.8
do.	May 22	16.2
Unfumigated check	March 26	7.4
	May 22	3.7

*Tonnage figures were obtained from Edsel C. Jorgenson, Nematologist U.S.D.A., A.R.S., C.R.D., who conducted a soil fumigation experiment in the same eight-acre field. Harvest and late planting dates were comparable with the variety evaluation test. Calculation of tons beets per acre was based on marketable beets.

P A R T V

VIRUS YELLOWS INVESTIGATIONS

and

BREEDING FOR YELLOWS RESISTANCE

Foundation Project 12

C. W. Bennett
J. M. Fife
J. C. McFarlane
J. E. Duffus

PROJECT 12

BREEDING FOR RESISTANCE TO VIRUS YELLOWS

J. S. McFarlane and C. W. Bennett

During 1959, major emphasis was placed on selecting for resistance within sugar beet strains which had shown tolerance in previous tests. Seed increases were made of 1958 selections and preliminary evaluation tests were conducted. Additional information was obtained on the mode of inheritance. Bagged crosses were made between promising yellows tolerant selections and superior bolting resistant breeding stocks.

Seed Increases from 1958 Selections

Seed increases were made of the 1958 yellows tolerant selections from 8 self sterile and 10 self fertile lines. Selfed seed was saved from individual plants in the self fertile material. Polycross seed was obtained from individual plant selections from self sterile lines. The selected roots proved to be susceptible to rotting, and losses prior to seed production were heavy, especially in the inbred material. This is a problem which will undoubtedly continue to give trouble with field selections. The selected roots are very succulent, because the plants in the selection plot are wide spaced to minimize competition and selecting is based partially on root size. In addition, all selected roots have yellows which apparently predisposes them to rot.

Selections for Yellows Resistance

Second successive selections for yellows resistance were made from individual plant progenies of the 1958 selections. These selections were made from a 4-acre field plot which was planted in a checkerboard arrangement so that each plant occupied an area 28 x 28 inches. Selections were based on relative freedom from top symptoms and on root size. Striking differences were observed in the amount of yellowing and necrosis which occurred in the different polycross and selfed progenies. Progenies from a yellows tolerant line furnished by Dr. Henk Rietberg of The Netherlands were outstanding from the standpoint of yellowing. Selections from two bolting resistant inbreds from the Salinas program also were relatively free from yellowing.

Selections were also made from bolting resistant monogerm lines and from Type O multigerm lines.

Yellows Resistance Evaluation Tests

Field tests were planted at Salinas on May 8 and June 11, 1959. The degree of resistance was determined by comparing inoculated and non-inoculated plots of each variety or breeding stock. Inoculations were made with a virulent strain of the yellows virus by means of the green peach aphid.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

The May planting consisted of separate tests of 9 varieties and 9 inbreds. Included in the variety tests were 3 F_1 hybrids, 663, US 75, 2 selections for yellows resistance from US 75, and 2 hybrid varieties. The inbred test included a group of inbreds which had been used to produce the F_1 hybrids, inbreds which showed promise in 1958, and the susceptible 5511 inbred. Four replications were used in both tests. The plots were 2 rows wide by 40 feet long in the variety test and 2 rows wide by 26 feet long in the inbred test. Spraying to control the aphid vectors was started on May 21 and continued at 7-10 day intervals through August 15. Inoculations were made on June 30. The plots were harvested September 24.

A late planting was made on June 11 to obtain preliminary information on progress made in selecting for yellows resistance during the 1958 season. Seed from the 1958 selections was produced in the greenhouse and harvested during early June. Seed supplies were limited, so it was necessary to composite the polycross progenies from individual lines for use in the evaluation test. Four replications with 26-foot, single-row plots were planted. Systox sprays were applied at 7-10 day intervals beginning June 25 and ending August 15. Inoculations were made July 27. The tests were harvested October 23.

Infection ranging between 90 and 100 percent was obtained in nearly all inoculated plots in both dates of planting. Yellows gradually spread to the non-inoculated plots and probably caused some damage, especially in the June planting.

The results of the May 8 planted tests are shown in Tables 1 and 2. The range in yield reduction from yellows among both the varieties and the inbreds was much less in 1959 than in the two previous years. The differences observed among varieties were not significant and those observed among inbreds were barely significant at the 5-percent level. The two selections which had been made from US 75 for yellows resistance failed to show any less damage than did the parent strain. The 5511 inbred, which in previous tests had proved very susceptible to yellows, was not damaged any more severely than were most other inbreds.

The results of the June planted test are shown in Table 3. Differences observed between the selections and the parent lines were not significant. The line 56-1022-0 which was outstanding in 1958 was no better than the other lines included in the 1959 test.

The disappointing results with the 1959 evaluation tests do not necessarily mean that progress in selecting for resistance is lacking. In previous years, significant differences were demonstrated among the various varieties and breeding stocks which were tested. The reason for the irregular behavior in 1959 is not fully known but must in some way be associated with the season and its effect on the expression of the yellows. Growing conditions were excellent and the top growth was unusually vigorous. Yellowing and stunting were less pronounced in the 1959 tests and especially in the June planting. It is probable that an earlier date of planting would be more desirable, but this would necessitate a delay of one year in testing the progenies of the field selections. In so far as seed supplies permit, the progenies of the 1958 selections will be retested in 1960.

Table 1.--Effect of virus yellows on the yield of sugar beet varieties at Salinas, California. (Planted May 8 and harvested September 24, 1959.)

Variety	Description	Acre Yield Check	Acre Yield Yellows	Reduction in yield	Harvest Count Check	Harvest Count Yellows
		Tons	Tons	Percent	Number	Number
F58-547H1	MS of NB1 x NB5	26.83	22.22	17.2	149	145
5511H1	MS of NB1 x NB2	26.74	21.74	18.7	139	138
863H8	7569HO x 663	28.59	22.56	21.1	149	148
368	US 75	28.21	21.84	22.6	159	156
863H1	US H2	31.13	23.88	23.3	151	148
811	V.Y. sel. from 368	29.47	22.49	23.7	154	154
911	V.Y. sel. from 368	28.72	21.42	25.4	156	159
F57-554H1	MS of NB1 x NB4	33.39	24.54	26.5	143	140
663	N.B., C.T. sel. (US 15 x US 22/3)	30.58	21.62	29.3	148	148
					Beets per 100' row	

Table 2.--Effect of virus yellows on the yield of sugar beet inbreds at Salinas, California. (Planted May 8 and harvested September 24, 1959.)

Inbred	Description	Acre Yield Check	Acre Yield Yellows	Reduction in yield	Harvest Count Check	Harvest Count Yellows
		Tons	Tons	Percent	Number	Number
7569HO	Male sterile monogerm	25.51	19.84	22.2	150	150
SL7553	Monogerm inbred	27.94	20.64	26.1	144	144
F57-554	NB4 inbred	21.88	15.98	27.0	150	150
8539	Bolt.res inbred	27.96	19.59	29.9	160	158
5547	NB5 inbred	21.20	14.81	30.1	142	142
5502H1	MS of NB1 inbred	23.97	16.69	30.4	142	140
SL7511	Monogerm inbred	23.16	16.07	30.6	142	148
5511	NB2 inbred	22.19	14.81	33.3	110	110
SL7547	Monogerm inbred	23.97	14.45	39.7	150	150
	LSD at 5% point			8.4	Beets per 100' row	

Table 3.--Effect of virus yellows on the yield of sugar beet varieties and selections from these varieties at Salinas, California. (Planted June 11 and harvested October 23, 1959.)

Variety	Description	Acre Yield		Reduction	Harvest Count	
		Check	Yellows	in yield	Check	Yellows
		Tons	Tons	Percent	Number	Number
M9 S/2	V.Y.tol.sel.from Dr.Hull	20.47	13.60	33.6	150	154
922	Salinas sel. from M9 S/2	23.79	17.01	28.5	142	146
L6 S/3	V.Y.tol.sel.from Dr.Hull	18.00	13.96	22.4	127	127
923	Salinas sel. from L6 S/3	18.71	14.14	24.4	142	146
A7 S/1	V.Y.tol.sel.from Dr.Hull	19.62	14.36	26.8	127	127
925	Salinas sel. from A7 S/1	20.82	16.46	20.9	150	150
55RF393	American Crystal inbred	19.74	14.36	27.3	138	142
926	Salinas sel. from 55RF393	16.75	11.78	29.7	119	123
56-1022-0	V.Y.tol.sel.from Dr.Rietberg	17.90	13.78	23.0	150	150
928	Salinas sel. from 56-1022-0	17.77	12.92	27.3	142	138
					Beets per 100' row	

Inheritance of Resistance to Yellows

Included in the May planting were 4 inbreds and 3 hybrids involving these inbreds. Also included were the male sterile 7569HO, the top cross parent 663, and the hybrid between them. Results with these parents and their hybrid combinations are shown in Table 4. The loss from yellows was less with each of the hybrids than it was with either parent. These results agree with those obtained in 1958.

The results indicate that either resistance to yellows is partially dominant or that inbreds tend to be more subject to damage than are hybrids.

Hybridization Work

Bagged crosses were made between several of the more promising self sterile clones which were selected in 1958. Crosses were also made between these clones and bolting resistant self fertile lines. The annual gene is being introduced into a few of the selected lines with the objective of producing two or more generations a year and thereby speeding up the selection process.

Table 4.--Percent reduction in yield of sugar beet inbreds and their hybrid combinations when inoculated with yellows at Salinas, California in 1959.

Inbred or Variety	Description	Reduction in yield
		Percent
5502H1	MS of NB1	30.4
F57-554	NB4 inbred	27.0
F57-554H1	MS of NB1 x NB4	26.5
5502H1	MS of NB1	30.4
5547	NB5 inbred	30.1
F58-547H1	MS of NB1 x NB5	17.2
5502H1	MS of NB1	30.4
5511	NB2 inbred	33.3
5511H1	MS of NB1 x NB2	18.7
7569H0	MS of 6515 x 7569	22.2
663	US 15 x US 22/3	29.3
863H8	7569H0 x 663	21.1

PROJECT 12

STUDIES ON THE ECONOMIC IMPORTANCE OF THE RADISH YELLOWS VIRUS ON SUGAR BEET

James E. Duffus

Summary

Radish yellows virus, an entity capable of inducing foliage yellowing of sugar beet indistinguishable from isolates of the beet yellows virus, has been found to be widespread in beet plantings in California and Oregon. Indexing has indicated that it may be more prevalent in these areas than the beet yellows virus.

Replicated field tests on sugar beets have indicated that isolates of the radish yellows virus are capable of inducing serious losses in sugar yield. These losses are apparently additive to losses produced by the beet yellows virus when the viruses occur simultaneously in the same plants.

The implication of the widespread occurrence of the radish yellows virus in California sugar beet plantings, coupled with the effect of the virus on sugar yield, is the possible need for the incorporation of resistance studies to this entity as well as the beet yellows virus in a breeding program.

Introduction

The radish yellows virus, an entity capable of inducing foliage yellowing on sugar beet and other crop and weed plants, has not previously been studied extensively in regard to the damage caused by this virus under field conditions. This virus, which produces yellowing of the beet crop indistinguishable from isolates of the beet yellows virus, has been found in limited indexings to be widespread in beet plantings in California (2).

Studies in Europe and in the United States (1,4) have indicated that the sugar beet yellows virus in replicated field tests can cause reductions in root yields ranging from approximately 13 to 50 percent, depending upon vigor of the plants, virulence of the virus isolate used, and date of infection.

Since it was known that the radish yellows virus was widespread in California sugar beet plantings in association with the beet yellows virus, it became of interest to determine more precisely the relative incidence of the two viruses in such plantings. It was also desirable to determine in replicated field tests the damage inflicted on the sugar yield of beets by the radish yellows virus alone and in combination with the beet yellows virus. The results of these studies are found in this report.

Results

Recovery tests from field sugar beets.--Recovery tests from yellowed field sugar beets in the Salinas and San Joaquin valleys of California and from the Medford and Salem areas of Oregon were conducted in an effort to determine the relative incidence of the beet and radish yellows viruses in these areas. The viruses were recovered by feeding nonviruliferous green peach aphids (*Myzus persicae* (Sulz.)) in the greenhouse on randomly collected field plants showing yellowing symptoms. The insects were allowed to feed on the collected plants for about 24 hours and were then transferred to healthy indicator seedlings for about 48 hours. The technique was essentially the same as described previously (2) and included *Chenopodium amaranticolor* Coste & Reyn., *C. capitatum* (L.) Asch., *Capsella bursa-pastoris* (L.) Medic., *Malva parviflora* L., and *Beta vulgaris* L. as test plants.

The results of these indexings (Table 1) indicate that the radish yellows virus is of high incidence in sugar beet plantings in every growing area tested. In all areas tested, it was found to be more prevalent than the beet yellows virus. In the seed fields of Oregon, the radish yellows virus was recovered from all of the 56 plants tested, whereas the beet yellows virus was recovered from only one.

Table 1.--Results of virus recovery tests from field sugar beet plants showing foliage yellowing: 1958-1959.

Area	No. plants tested	No. of plants from which the indicated viruses were recovered.		
		Radish yellows virus only	Beet yellows virus only	Radish and beet yellows viruses
San Joaquin Valley, Calif., - 1958	40	25	0	3
Salinas Valley, Calif., - 1958	20	15	2	3
San Joaquin Valley, Calif.,- 1959	107	38	21	36
Salinas Valley, Calif., - 1959	152	55	25	37
Santa Clara Valley, Calif., - 1959	24	15	0	1
Oregon Seed Fields - 1959	56	55	0	1
Totals	399	203	48	81

Although relatively few plants were sampled in these tests, there seems to be no reason to believe that the relative distribution of the two viruses has not been obtained.

Field inoculation tests.--In an effort to determine the effects of the radish yellows virus alone and in combination with the beet yellows virus on sugar yield, replicated field plots were established in a 1/3-acre field of US 75 sugar beets planted January 10, 1959, near Salinas, California. Plots were 30 feet long and 3 rows wide and were arranged in 4 latin squares. The 4 treatments consisted of uninoculated (control) plots, plots inoculated with a fairly severe isolate of the radish yellows virus, plots inoculated with a fairly severe isolate of the beet yellows virus, and plots inoculated with both the radish and beet yellows isolates. Inoculation was carried out during the week of April 1 by the method described by Bennett et al. (1), in which leaf pieces each containing about 10 aphids were clipped off the source plants onto the plants being inoculated. Within 48 hours after inoculation and at approximately 2-week intervals thereafter until July 1, the plots were sprayed with Systox at 1 pint/acre. The beets were harvested August 27. Yields and sucrose percentages were determined for each plot.

Fairly high percentages of infection were obtained in the inoculated plots with approximately 84 percent of the plants in the radish yellows plots infected and 92 percent in the beet yellows plots. The control plots following inoculation of the other plots had less than 1-percent infection. Aphid populations were low during early summer but tended to increase during the latter part of the season. The plots could be readily separated on the basis of color differences by May 6 and remained that way until the latter part of July when virus spread made distinguishing the plots more difficult. On the basis of yellowing, the plots inoculated with the combination of radish and beet yellows viruses were the most severe. The beet and radish yellows plots followed, in that order.

The results of the yield tests are shown in Table 2.

Table 2.--Effect of radish and beet yellows virus on yield and sucrose content of sugar beet in tests at Salinas, California, 1959.

Plots inoculated with indicated viruses	Sucrose (percent)	Yield of beets per acre (tons)	Gross sugar per acre (pounds)
Noninoculated (control)	15.42[a]	37.64[a]	11,603[a]
Beet yellows virus	14.91[ab]	31.38[b]	9,358[b]
Radish yellows virus	14.57[b]	32.16[b]	9,374[b]
Beet yellows virus and Radish yellows virus	14.48[b]	26.13[c]	7,562[c]

[a,b,c]Any two means with different superscripts are significantly different from each other at the 0.01 level.

The analysis of the data was handled by E. James Koch of Biometrical Services, Beltsville, Maryland.

The analysis of the sucrose content data indicates that inoculation with both the radish and beet yellows viruses resulted in a significant lowering of sugar percent, but the interaction between the two was not significant. The Duncan comparison (3) shows that beet yellows reduced the sucrose content significantly but that inoculation with the radish yellows virus either with or without beet yellows significantly reduced the sucrose content further.

Analysis of the yield data indicates a highly significant effect for inoculation with both beet and radish yellows viruses but no interaction between the two types of yellows. The beet and radish yellows viruses caused yield reductions of 16.6 and 14.6 percent respectively, while the combination of viruses caused a 30.6 percent reduction. The Duncan comparison indicated that all yellows inoculated plots were significantly lower than the control. There was no significant difference between the yield effects of these isolates of the radish and beet yellows viruses but a highly significant reduction in yield with the combination as compared to either virus alone.

Analysis of gross sugar data showed a highly significant reduction in sugar by inoculation with both radish and beet yellows viruses. A reduction of approximately 19 percent was recorded for both viruses.. Whereas, the combination caused a reduction of 34.8 percent.

Discussion

The indexing of nearly 400 sugar beets from California and Oregon has indicated a widespread occurrence of the radish yellows virus. Although the number of plants sampled has been relatively low, indexings have shown a high incidence of the radish yellows virus in yellowed sugar beets either alone or accompanied by the beet yellows virus. In all areas tested, the radish virus seemed to be more prevalent than the beet yellows virus.

Yield data have indicated that isolates of the radish yellows virus are capable of inducing serious damage to sugar yield of the beet crop. The addition of both the radish and beet yellows viruses in the same plants apparently results in an additive effect on yield reduction.

It was apparent in these tests that the amount of foliage yellowing in field sugar beets with mixed infections of the beet and radish yellows viruses was of little aid in determining the damage caused by the entities.

The radish yellows virus with its widespread distribution and prevalence in California and Oregon beet growing areas and its ability to cause serious yield reduction is of economic significance. Since resistance of plants to the effects of one virus does not, in general, give resistance to the effects of other viruses, it may be important to incorporate resistance studies to the radish yellows virus as well as the beet yellows virus in a breeding program.

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PROJECT 12

STUDIES TO DETERMINE SATISFACTORY GROWTH CONDITIONS FOR SUGAR BEET PLANTS FOR SELECTION OF INDIVIDUALS ON THE BASIS OF THEIR AMINO ACID CONTENT FOR POSSIBLE RESISTANCE TO VIRUS YELLOWS

J. M. Fife

Introduction

It has been shown by paper chromatography that a striking amino acid pattern develops in the leaves of sugar beet plants showing the chronic symptoms of virus yellows. Under optimum conditions for growth, the concentration of aspartic acid and glutamic acid may decrease as much as 60 percent in the mature leaves of beet plants showing the chronic symptoms of the disease. In these same leaves, the concentration of citrulline and alanine increases, in many cases, to more than double the concentration found in leaves of healthy control plants. If the ratio, aspartic acid + glutamic acid/citrulline + alanine, is calculated for the healthy and diseased plants, the resulting values are so different that the diseased plants can be readily indentified. A test conducted in the field in 1957, involving 121 selections, gave a mean ratio of 1.41 and 0.59 for the healthy and diseased plants, respectively. Twenty-eight selections tested in 1958 gave ratios of 1.26 and 0.32 for healthy and diseased plants, respectively. It was observed also that the amino acid ratio for the healthy plants of the field grown selections varied over a wide range, indicating that the concentration of the amino acids may vary among sugar beet selections.

Tests, conducted in the greenhouse, have shown that a wide variation in the amino acid pattern exists between individual plants of the same selection. A papergram typical of the differences observed in the concentration of certain amino acids in the expressed juice of mature leaves from healthy plants and leaves from plants showing yellows is shown in Figure 1. This suggested that the above amino acid ratio may be used as a tool to identify individual plants which may have resistance to virus yellows.

In order to select plants for possible resistance to virus yellows on the basis of the amino acid ratio, the first condition that must be met is that the concentration of the individual amino acids involved must reveal an inherent difference between individual plants and not changes or differences in the external environment.

The object of these studies was: 1) to determine the conditions under which the selection of individual plants, by the amino acid ratio, for possible resistance to virus yellows, can be carried out the most effectively; 2) to determine the conditions under which the relative damage, to the roots of the selections, may be accurately determined; 3) to select individual diseased plants, having a relatively high amino acid ratio for seed increase; and 4, to select roots which have made superior growth despite the disease.

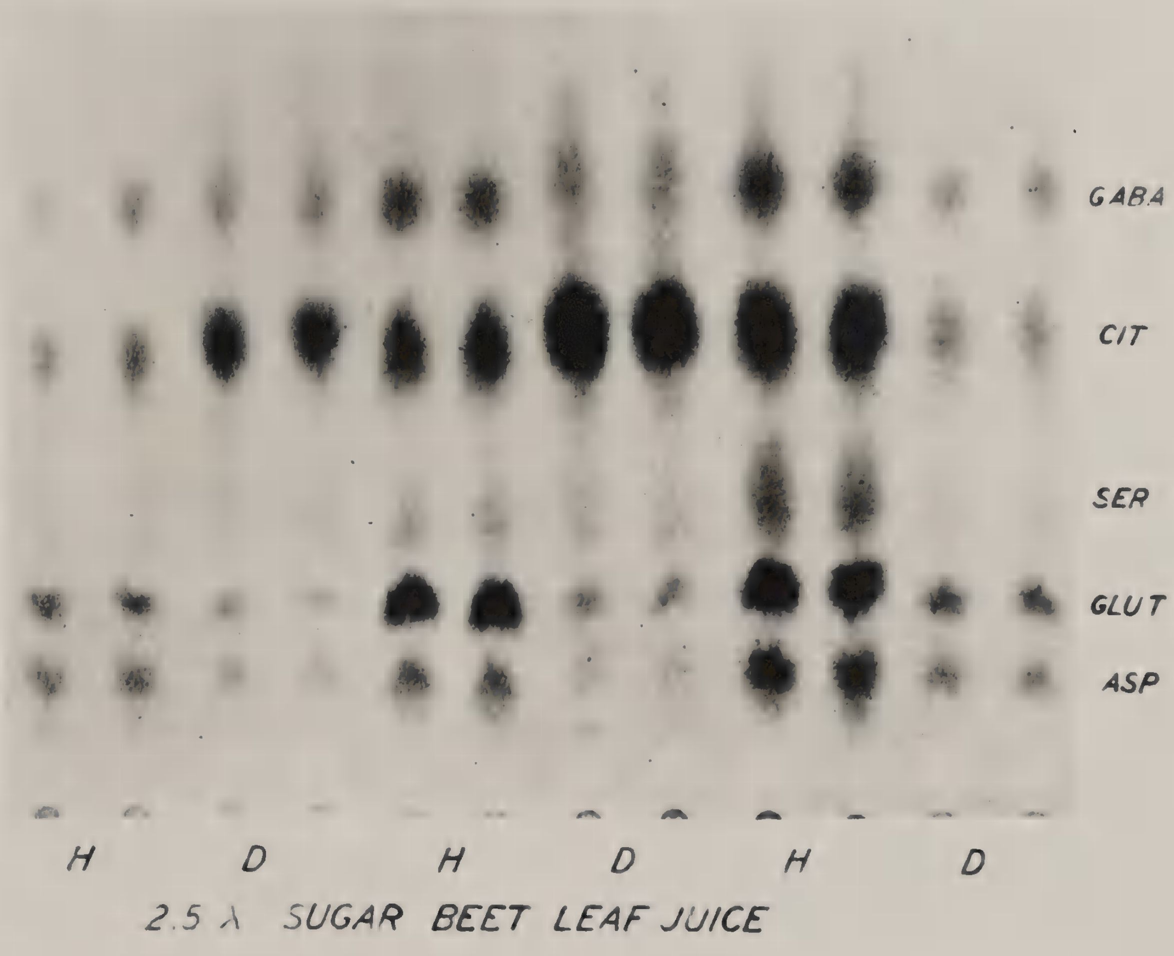

Figure 1.--Papergram, developed in water-saturated phenol, of juice expressed from mature leaves of 3 healthy and juice from leaves of comparable age from 3 plants having yellows showing. Aspartic acid (asp), Glutamic acid (glut), Serine (ser), Citrulline (cit), and Gamma-aminobutyric acid (gaba). H - Healthy leaf; D - Diseased leaf.

Amino Acid Ratios of Sugar Beet Selections
Grown in the Field and Greenhouse

Tests have shown that the concentrations of the amino acids in beet leaves are greatly influenced by the nitrogen level to which the plants are subjected. In view of this, a comparison was made of the range in the concentration of certain amino acids and the resulting amino acid ratio, in selections grown in the field and selections grown under greenhouse conditions.

The healthy plants of 121 of the selections grown in the field in 1957 and 28 of the selections grown in the field in 1958 were compared with healthy plants of sugar beet selections grown in the greenhouse. The greenhouse tests were conducted in soil maintained at a uniform nitrogen level by weekly applications of Hoagland's solution. The results of this comparison are shown in Figure 2.

It is evident, in view of the wide range through which the concentration of the amino acids varied in the selections grown in the field, why the amino acid ratio itself varied so widely. The range of the amino acid ratios in the field tests were four times greater than the range observed in the selections tested in the greenhouse. In view of the relatively narrow range through which the amino acids varied in the greenhouse tests, it was suspected that the variation found in the field tests was not due to inherent differences among selections but to soil variation and variation in the nitrogen level within the plot.

In order to shed further light on the nature of this soil variation as reflected in the concentration of the amino acids in the leaves of selections grown in the field tests, a plot was made of the concentration of the amino acids in relation to the position in the plot occupied by the selections grown in one block of the 1957 planting. The results are shown in Table 1.

It is evident that the amino acids, and especially glutamic acid, varies greatly from row to row despite the fact that the selections were from the same parent. For example, in selections from 6507 parent, the concentration of glutamic acid was 18, 40 and 71 mg. percent, respectively, in the selections growing in rows 11, 13, and 15. This is a progressive increase of 122 percent in the selection growing in row 13 (over the selection growing in row 11) to 294 percent in the selection growing in row 15. Aspartic acid did not make the same proportional gains, as did glutamic acid, in these same selections. The concentration of aspartic acid increased only 23 and 70 percent, respectively, over the selection in row 11. The concentration of citrulline + alanine decreased 6 percent and increased 56 percent, respectively, under the same conditions.

It appears doubtful that selection 6507-8 is so inherently different from 6507-4 to account for the difference observed in the concentration of the amino acids and the resulting difference between the two amino acid ratios; namely, 0.74 and 1.35.

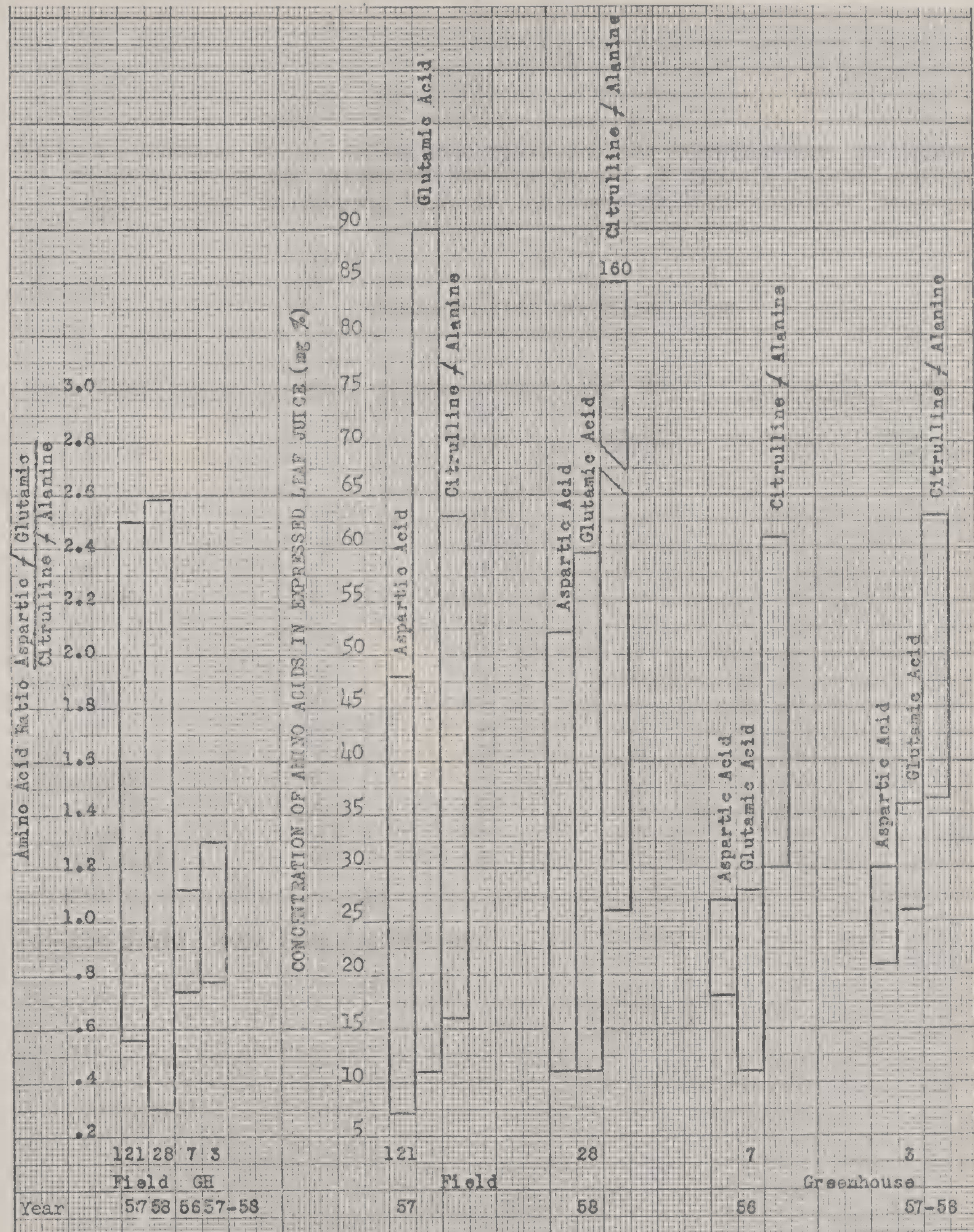

Figure 2.--Comparison of the range in concentration of certain amino acids and the amino acid ratio in selections grown in the field with selections grown in the greenhouse.

Table 1.--Changes in the amino acid ratio and the concentration of certain amino acids in the leaves of healthy plants of closely related selections growing in adjacent rows in the same block in the 1957 field planting.

Selection	Row	Concentration of Amino Acids			Ratio
		Aspartic	Glutamic	Cit.+ Al.	
		Mg.%	Mg.%	Mg.%	Asp.+ Glut. / Cit.+ Al.
6507-14	7	28	31	33	1.26
-20	9	17	26	33	.96
-4	11	17	18	34	.74
-23C2	13	21	40	32	1.49
-8	15	29	71	53	1.35
-1	17	25	45	35	1.59
-3C2	19	25	48	36	1.52
-2C2	21	24	31	32	1.25
-18	23	19	48	26	1.42
6507	25	30	36	34	1.44
6568-101C2	27	28	55	37	1.54
-146C2	29	16	23	35	.89
-109C2	31	48	63	43	1.82
-15-3C2	33	19	57	47	1.19

Two-row plots, even rows inoculated.

The amino acids were determined in the healthy mature leaves of selections grown in the greenhouse in soil. The nitrogen level in the soil was maintained at a uniform level by weekly applications of 100 ml of Hoagland's solution containing 200 ppm of nitrogen to each pot after the plants had reached the four-leaf stage. Leaf samples were taken from 10 individual plants of each selection and analyzed separately. The mean values of the amino acids determined are shown in Table 2.

Although these selections show a wide range in susceptibility to curly top, yet they show little variation in the concentration of the amino acids or the amino acid ratio.

To summarize the variability among selections and individual plants grown in the field and in the greenhouse, glutamic acid was selected because it appears to be the most sensitive, of the amino acids, to changes in the nitrogen level of the media in which the plants are growing. The results are shown in Table 3.

In all cases, the coefficient of the variation was greater in the selections and individual plants grown in the field than in those grown in the greenhouse. A mean of all the tests shows that the coefficient of variation in the greenhouse plants is only one-half the variation found in the field-grown plants.

It appears that the observed variation in the amino acid concentration and the resulting amino acid ratios, in the field-grown selections, is due largely to variations in soil fertility; namely, nitrogen.

Greenhouse Tests at Different Nitrogen Levels

Experiments were conducted in the greenhouse to determine the optimum nitrogen level, and other conditions most favorable, for the selection of individual plants for possible resistance to virus yellows, using the amino acid ratio, and for determining the reduction in root weight due to the disease.

In one test, four redwood boxes were filled with sand and watered with Hoagland's solution. Four nitrogen levels of 25, 50, 100 and 200 ppm were maintained throughout the experiment. Variety US 75 was planted. Six weeks after emergence one-half of the plants were inoculated. The plants were harvested and root weights taken 64 days after the plants were inoculated. A parallel test was conducted in six-inch pots in fertile potting soil and treated in the same manner, except these plants received weekly applications of 100 ml of Hoagland's solution containing 200 ppm of nitrogen after the plants had attained the four-leaf stage. The amino acids were determined in the mature leaves of each individual plant and mean values reported in Table 4. The root weights and correlating data are reported in Table 5.

Table 2.--Concentration of certain amino acids in the healthy mature leaves of sugar beet selections grown in the greenhouse in soil under uniform conditions as to nitrogen fertilization.

Concentration of Amino Acids

Selection	Aspartic	Glutamic	Cit.+ Al.	Ratio $\frac{\text{Asp.+ Glut.}}{\text{Cit.+ Al.}}$
	Mg.%	Mg.%	Mg.%	
753	20	16	40	0.90
1-300	22	21	38	1.13
4554	20	16	43	0.83
4511	22	18	43	0.94
96	20	11	41	0.75
79	22	25	42	1.03
93	18	13	38	0.80
US 75	21	29	64	0.78
743	27	27	61	0.88

Table 3.--A comparison of the coefficient of variation in the concentration of glutamic acid among sugar beet selections and among individual plants grown in the field and in the greenhouse.

Year	Location	Selections & plants	Glutamic Acid Mg.%	Std. Dev.	Coeff. of Var. $\frac{S}{\bar{X}}$ .100
	Selections	No.	$\bar{X}$	S	C
57	Field	123	42.1	16.4	39.4
57	" (selections in 1 block)	14	42.3	15.8	37.4
58	"	28	24.4	11.4	46.8
	Individual Plants				
56	Field (Gaskill)	5	20.0	8.6	43.0
56	" (US 75)	5	16.2	5.6	34.8
					40.3 Mean
	Selections				
56	Greenhouse, soil in 6" pots	7	17.2	4.7	27.6
56	" " " " " (US 75) (742)	2	27.6	1.4	5.1
	Individual Plants				
56	Greenhouse, soil in 6" pots (742)	10	26.6	4.1	14.4
56	" " " " " (US 75)	10	28.6	4.4	16.5
57	" " " " " (US 75)	10	46.3	14.9	32.2
58	" sand(N-100 ppm)(US 75)	10	25.7	6.4	25.1
					20.1 Mean

Table 4.--The concentration of certain amino acids in mature leaves of healthy and yellows affected beet plants growing in the greenhouse in soil and in sand culture at different nitrogen levels.

Amino Acid & % change	Soil[1] H	Soil[1] D	25 H	25 D	50 H	50 D	100 H	100 D	200 H	200 D
	Mg.%	Mg.%	Mg.%	Mg.%	Mg.%	Mg.%	Mg.%	Mg.%	Mg.%	Mg.%
Aspartic	12.1	8.9	9.1	9.6	20.4	5.8	15.6	6.3	15.8	6.8
Glutamic	32.6	20.6	24.2	26.2	53.4	29.0	49.4	23.8	60.0	21.6
Citrulline & Alanine	11.8	60.3	30.8	42.2	31.6	30.0	43.2	34.2	55.0	36.2
% Reduction										
Aspartic		26.4		0		71.5		59.6		57.0
Glutamic		36.8		0		45.7		51.8		64.0
Citrulline & Alanine		410.[2]		37.0[2]		5.1		20.8		34.2

Column heading: Ppm-Nitrogen in sand culture and condition (25, 50, 100, 200).

(1) Watered weekly with 100 ml of Hoagland's solution containing 200 ppm nitrogen.

(2) Percent increase.

Table 5.--Weight of roots of healthy and virus yellows affected sugar beet plants, of variety US 75, grown in sand at four nitrogen levels and in soil in the greenhouse.

Medium	Nitrogen level	Mean Weight* Healthy	Mean Weight* Diseased	Reduction	Relative increase in wt. due to higher N Healthy	Relative increase in wt. due to higher N Diseased
	ppm	Grams	Grams	Percent	Percent	Percent
Sand	25	37	22	41	100	100
	50	113	52	54	308	241
	100	256	103	60	697	480
	200	160	110	28	436	533
Soil		42	38	10		

*64 days after inoculation.

Aspartic acid and glutamic acid were found to be significantly lower in the leaves of the healthy plants growing in the soil and in sand watered with 25 ppm nitrogen than in plants growing at the higher nitrogen levels. At 50, 100, and 200 ppm of nitrogen, the concentration of aspartic acid was relatively constant at 16 to 20 mg. percent, while the concentration of glutamic acid was constant at near 50 mg. percent at 50 and 100 ppm nitrogen and 60 mg. percent at 200 ppm nitrogen.

The concentration of citrulline + alanine was lower in the healthy plants in soil than in the plants growing at the 25 ppm nitrogen level. These amino acids made the usual increase in the diseased plants, over that of the healthy plants, growing in the soil and at the 25 ppm nitrogen level, was unchanged at the 50 ppm nitrogen level, but was lower than the healthy plants at the 100 and 200 nitrogen level. Why the concentration of citrulline + alanine decreased at these nitrogen levels, as compared to the healthy plants in this experiment, cannot be explained at the present time.

The greatest percentage increase in root weight (Table 5) in the healthy plants occurred at the 100 ppm nitrogen level. The nitrogen level maintained in the soil was apparently so low that both the healthy and diseased plants were retarded in growth. As a result, the reduction in root weight due to the disease was relatively small in the plants grown in the soil.

The greatest percentage reduction in root weight due to the disease was approximately the same at the 50 and 100 ppm nitrogen levels, the reduction being 54 and 60 percent, respectively. It appears, from this test, that nitrogen levels above 100 ppm may have a tendency to reduce somewhat the damage to the roots caused by the disease.

From this experiment, and others conducted, it appears that a nitrogen level of 100 ppm, in sand culture, is near optimum for good growth of healthy plants and at a level where the relative reduction in root weight due to the disease is near the maximum. This nitrogen level is also near the optimum for symptom expression. At this level, typical symptoms of the chronic stage of the disease appear, including necrosis. At higher nitrogen levels, the chronic symptoms of the disease have been found to be masked somewhat.

Growth Rate of Roots of Healthy and Virus Yellows-affected Beet Plants

In order to assess accurately the damage done to the plants or selections by the disease, it is necessary not only to grow the plants under conditions optimum for growth but to harvest the plants at a time when the difference in weight between the roots of the healthy and diseased plants is greatest.

A reduction in root weight of as much as 60 percent, relative to that of healthy control plants, was obtained in two tests conducted in sand culture with the nitrogen level maintained near optimum for growth of the healthy plants. In these tests, the plants were small and the weight of the roots was increasing at a rapid rate at the time the tests were conducted. The tests indicate that the age at which the plants are inoculated and the interval between inoculation and harvest of the roots may influence considerably the magnitude of the difference in weight between the diseased and healthy plants. Experiments were therefore

conducted to determine the rate of growth of roots of healthy and inoculated beet plants growing in sand culture using a nitrogen level of 100 ppm.

The four redwood boxes mentioned earlier were planted with US 75 and all watered with Hoagland's solution containing 100 ppm nitrogen. Forty days after emergence, plants were dug for root weight determinations. The plants in two of the boxes were inoculated with virus yellows (strain 5). Healthy plants were removed at 3, 6, 8 and 10 weeks following inoculation for root-weight determinations. The diseased plants were sampled 8 and 10 weeks following inoculation and root weights obtained.

In another test conducted at the same time, a large box was constructed, filled with sand and watered from the same tank of Hoagland's solution. One hundred plants (US 75) were grown in the box and all plants inoculated. In this test, diseased plants were removed at the end of 8 and 11 weeks, following inoculation for root weight determinations. The results of these two tests are shown in Figure 3.

Under the conditions of this experiment, the roots of the healthy plants approached their maximum rate of growth about 80 days after emergence. During the two-week period, from the 82nd to the 96th day, the mean rate of growth of the roots was 3.21 grams per day and 5.25 grams per day during the following two weeks of growth.

In another test, conducted during the winter months when the light intensity and day-length were not optimum, a maximum rate of root growth of 4.50 grams per day was attained between the 112th and 126th day after emergence.

It appears, from the slope of the curve of the healthy roots, that a growth rate of 5.25 grams per day is near the maximum rate attainable under the conditions of the experiment. The rate of growth of the roots of diseased plants (test 315), for the period between the last two sampling dates, was 1.07 grams per day. The reduction in root weight due to the disease was 24.7 percent at the end of 8 weeks of growth after inoculation. Up to this time, the healthy roots had not yet attained their maximum rate of growth. When the plants were allowed to grow 14 days longer, during which time the growth rate of the healthy roots was at the maximum (5.25 grams per day), the reduction in root weight due to the disease was 49.4 percent.

If an estimate of the weight of the healthy roots is made by extending the growth curve, (Figure 3) at its measured rate of 5.25 grams per day, for seven days longer, a weight of approximately 220 grams would be obtained. This should be compared to the observed weight of 88 grams for the diseased roots, of Experiment 317, for the same growth period. It appears then, that, had the healthy roots been grown for one week longer, or 77 days following inoculation, a 60 percent reduction in root weight due to the disease would have resulted. In fact, in two tests, a 60 percent reduction in root weight due to the disease was obtained.

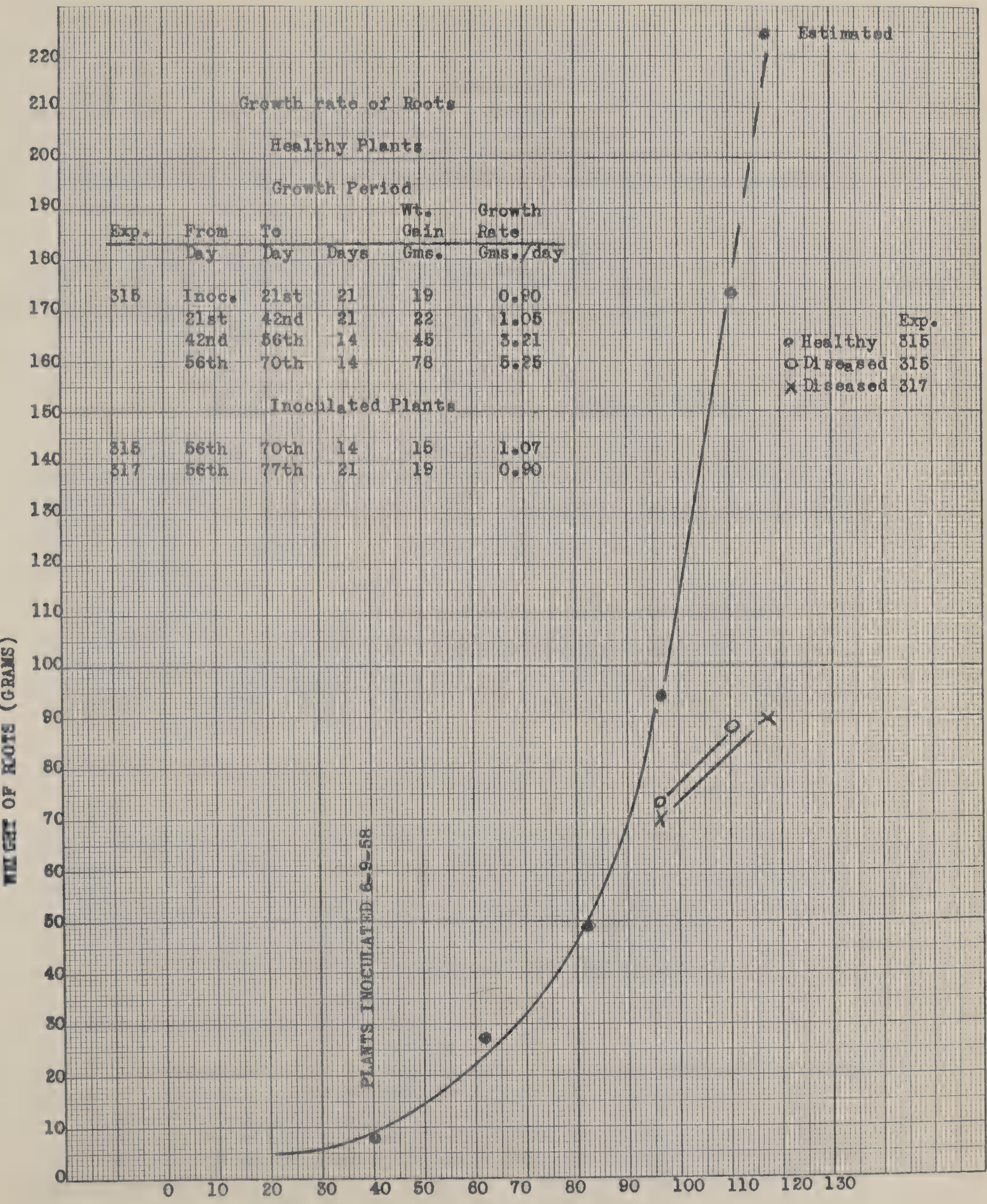

Figure 3.--Changes in root weight of healthy and virus yellows-infected beet plants at intervals from the time of inoculation

Table 6 summarizes the tests, involving nitrogen level, age of plants at time of inoculation, and days of growth following inoculation, on the reduction in root weight due to the disease. It appears, from Experiment 321, that the disease has little or no effect upon the rate of growth of roots immediately following inoculation of the plants, indicating that the reduction in growth of the diseased plants may be the result of an accumulation of substances in the plant.

It appears that, for a maximum difference between weight of roots of healthy and diseased plants, the plants should be inoculated from 30 to 40 days after emergence and allowed to grow 60 to 75 days after inoculation before root weights are taken.

Selection of Diseased Roots on the Basis of the Amino Acid Ratio and on Root Size for Seed Production

In four major experiments, conducted during the past year, more than 700 plants were grown in the greenhouse, under uniform conditions as to nitrogen fertilization. The concentration of four amino acids was determined and the amino acid ratio, aspartic acid + glutamic acid/citrulline + alanine, calculated for the healthy and diseased plants. The weight of each root was also recorded.

The standard diviation of the amino acid ratio was determined for each experiment. The diseased plants, having amino acid ratios greater than the mean, for the group, by at least twice the standard deviation were included in the primary selection of roots for seed production. Diseased plants having superior root weights were selected on the same statistical basis and saved for seed production.

Summary

Mature leaves of sugar beet plants showing the chronic symptoms of virus yellows have an amino acid pattern which is quite different from healthy leaves of the same age. If the amino acid ratio, aspartic acid + glutamic acid/citrulline + alanine, is calculated for the healthy and diseased plants, mean ratios of 1.28 and 0.32, respectively, are typical of values obtained. The amino acid ratio, in diseased plants, was found to vary significantly among individual plants within selections. This indicates that the concentration of the amino acids, expressed as a ratio, in the leaves of diseased plants, may be used as a means of identifying individual plants which may or may not show resistance to virus yellows.

Tests were conducted to determine: 1) the conditions under which the selection of individual plants, by the amino acid ratio, for possible resistance to virus yellows, may be carried out the most effectively; 2) the conditions necessary to accurately measure the relative reduction in root weight due to the disease. Diseased plants, having a relatively high amino acid ratio were selected for seed production. Roots which made superior growth, despite the disease, were also selected for seed production.

Table 6.--Reduction in root weight of virus yellows infected beet plants in relation to nitrogen level and length of growing period.

Exp.	Nitrogen	Age at Inoc.	From Inoc.	Harvest Date	Root Weight Healthy	Root Weight Diseased	Reduction
	Ppm	Days	Days		Gms.	Gms.	Percent
298	50	32	58	7-24	14.8	9.4	36.5
	210				59.8	36.1	60.2
	1000				47.8	26.7	55.8
311	25	40	74	3-20	36.8	21.6	41.3
	50				113.3	51.9	55.1
	100				256.4	103.4	59.6
	200				160.4	114.8	28.4
315	100	40	56	8-18	92.7	70.3	24.1
			70		171.4	86.5	49.6
321	100	35	21	1-5	13.9	15.9	0
			42		24.1	23.3	0
			63		64.6	41.7	35.5
			91		162.9	118.9	27.1

The concentration of each of four amino acids was determined in composited leaf samples of healthy and diseased leaves of selections and in leaves of individual plants grown in the field and in the greenhouse.

The range or "spread" in the concentration of the amino acids and the resulting amino acid ratio were four times greater in the plants grown in the greenhouse. The coefficient of variation in the concentration of glutamic acid, which is a sensitive indicator of nitrogen variability in the soil, in healthy plants grown in the field was 40 percent as compared to only 20 percent for the plants grown in the greenhouse.

Tests were conducted in the greenhouse to determine the nitrogen level most favorable for the selection of individual plants, on the basis of the amino acid ratio, for possible resistance to virus yellows.

The greatest percentage increase in root weight for the healthy plants and the greatest percentage reduction in root weight due to the disease occurred when the nitrogen level was maintained at 100 ppm in sand culture. The concentration of the amino acids was stable in leaves of plants at this nitrogen level.

Three factors have been found to influence the relative reduction in root weight between healthy and diseased plants. They are: the age of the plants at the time of inoculation, the rate of growth of the healthy roots during the interval between inoculation and harvest, and the duration of the interval.

A 60-percent reduction in root weight due to the disease, may be obtained by growing the plants in sand and watered with Hoagland's solution containing 100 ppm of nitrogen, inoculated when 30 to 45 days old, and allowed to grow 60 to 75 days after inoculation.

The sand culture method, using Hoagland's solution containing 100 ppm nitrogen, outlines conditions which are near optimum for growing plants for selection, by the amino acid ratio, for possible resistance to virus yellows. These conditions are also near optimum for determining the relative reduction in root weight due to the disease. Using this method, individual plants can be tested and selections made in a period of 100 to 120 days at any time during the year.

Diseased plants, having amino acid ratios greater than the mean by at least twice the standard deviation, were selected for seed production. Diseased plants having superior roots were selected on the same statistical basis and saved for seed production.

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PART VI

DEVELOPMENT AND EVALUATION
of
INBRED LINES AND HYBRID VARIETIES OF SUGAR BEETS
SUITABLE FOR CALIFORNIA

Foundation Projects 24 and 29

J. S. McFarlane I. O. Skoyen

Cooperators conducting tests:

American Crystal Sugar Company
Holly Sugar Corporation
Spreckels Sugar Company
Union Sugar Division
Kenyon Beatty - Brawley Test

REPORT ON FOUNDATION PROJECTS 24 AND 29

Summary of Accomplishments

J. S. McFarlane

Major attention in 1959 was placed on the development of superior monogerm breeding stocks which combine resistance to bolting and curly top. Information was obtained on the performance of male-sterile monogerm parents and inbred lines. Increased emphasis was placed on polyploid breeding.

BOLTING RESISTANCE.--The season of 1958-59 was unusually mild at Salinas and the amount of bolting was lower than is normally expected. Bolting determinations were made on 500 self-fertile monogerm segregates in an August 25, 1958, planting at the Research Station. Counts were also made in a group of 135 monogerm lines planted at Spence field on January 10. Bolting was only moderate in both of these plantings, so accurate evaluations of the more bolting-resistant lines were not obtained. The results indicated that we now have monogerm lines similar in bolting resistance to the more resistant multigerm lines.

MILDEW RESISTANCE.--Only a trace of mildew infection occurred at Salinas, so an evaluation of the monogerm lines was not made. Backcrosses of promising monogerm inbred lines to the highly mildew-resistant 8503 multigerm were made through the utilization of the gametocide, FW 450.

SEED INCREASES OF MONOGERM BREEDING STOCKS.--Seed increases were made of more than 200 self-fertile monogerm segregates which had been selected from F_2 populations involving crosses between multigerm and monogerm lines. Information was obtained on vigor, seed setting ability, and seed size. An increase was also made of a self-sterile monogerm derived from US 75 x SL320mm.

SEED LOTS MADE AVAILABLE THROUGH THE FOUNDATION.--A new monogerm inbred designated 9561-4 and a male sterile, 9561HO, from this inbred were made available in 1959. This inbred is an F_3 selection from a cross between NB1 and the bolting resistant monogerm 7507. In 1959 tests, 9561-4 showed good bolting resistance, moderately good curly top resistance, and good seed setting ability. The male-sterile 9561HO represents the first backcross to 9561 and may be used in the production of its male-sterile equivalent.

A monogerm F_1 hybrid between the MS of 7515 and 9561 was made available. This hybrid is being used as the female parent in the production of test quantities of three way hybrids.

Breeder's seed of Type O selections from US 15, Klein E, C366 was distributed. A bolting resistant self-sterile monogerm from US 75 x SL320mm was made available.

EVALUATION AND COMBINING ABILITY TESTS.--Tests to determine the combining ability of new inbreds were made by the USDA at Salinas and Brawley. Cooperative company tests were also made in the coastal area, the Imperial valley, and the Central valley. Results of these tests together with summary tables are included in this report. The results with the new monogerm hybrids were encouraging.

The monogerm hybrid (MS of 7515 x 7569) x 663 offers the greatest promise of those tested. In 11 tests conducted in the three major production areas of California, this hybrid produced a gross sugar yield which averaged 115 percent of US 75. The sucrose percentage averaged 104 percent of US 75 in the 11 tests. The hybrid has moderately good bolting resistance and is intermediate between US 56/2 and US 75 in curly top resistance.

US HYBRID VARIETIES.--Four US hybrids are being released for commercial use. The parentages of these hybrids are as follows:

US H2	(MS of NB1 x NB3) x 663
US H3	(MS of NB1 x NB3) x 366 or 586
US H4	(MS of NB1 x NB2) x 366 or 586
US H5A	(MS of NB1 x NB4) x 586
US H5B	(MS of NB1 x NB4) x 663

US H2 and US H3, which were described in the 1958 report, continued to perform well in the San Joaquin and Imperial valleys. US H4 is of interest primarily from the standpoint of high sucrose percentage coupled with moderately good yielding ability. It has performed particularly well in the later harvests in the Imperial valley. The bolting and curly top resistance of US H4 are only moderately good. US H5A and US H5B have good bolting resistance and may be expected to have moderately good mildew resistance. Both combinations have performed well in the coastal districts.

A summary of the results with the US hybrids for the period of 1957-59 is shown in the following table:

Variety	Year	Number of tests[1]			Performance in % of US 75					
					Gross Sugar Yield			Sucrose Content		
		C	CV	IV	Coast	Cent.Val.	Imp.Val.	Coast	Cent.Val.	Imp.Val.
US H2	1957	3	4	3	113	123	118	104	105	103
	1958	5	3	7	111	104	124	102	101	101
	1959	2	12	8	124	121	118	102	105	102
US H3	1957	4	4	2	107	101	108	107	106	104
	1958	5	1	7	96	96	106	103	107	104
	1959	2	7	7	111	104	111	104	107	105
US H4	1957	4	3	1	109	113	113	107	107	111
	1958	5	1	6	113	101	105	107	106	105
	1959	1	11	6	107	111	115	105	109	108
US H5A	1958	8	1	7	113	103	115	102	99	100
	1959	5	0	1	108	-	114	102	-	101
US H5B	1959	8	2	2	116	126	119	101	99	101

C = Coastal districts
CV = Central Valley
IV = Imperial Valley

MALE-STERILE PARENTS.--Extensive commercial use is being made of bolting-resistant male-sterile parents which have been developed in the USDA breeding program at Salinas. A table giving the description of 9 male-sterile parents is shown below. Included are male-sterile parents which are currently in commercial use and parents which have recently been made available for stock seed increase.

Parent	Combining Ability Tonnage	Combining Ability Sucrose	Bolting Resistance	Curly Top Resistance	Mildew Resistance	Type O
MS of NB1 x NB2	Good	Very good	Mod. good	Mod. good	Fair	Good
MS of NB1 x NB3	Very good	Good	Mod. good	Excellent	Poor	Good
MS of NB1 x NB4	Very good	Mod. good	Good	Mod. good	Good	Good
MS of NB1 x NB5	Very good	Mod. good	Good	Very good	-	Very good
MS of NB5 x NB6	Mod. good	Mod. good	Excellent	Very good	-	Good
C361HO	Very good	Good	Good	Very good	-	Good
F58-85HO	Very good	Good	Very good	Very good	-	Good
MS of 7515 x 7569	Good	Good	Good	Mod. good	-	Good
MS of 7515 x 7507	Good	Good	Good	Fair	-	Good

POLYPLOIDY.--In order to better evaluate polyploidy as a breeding tool, cooperative arrangements have been entered into with Dr. Bernström of the Hilleshög Sugar Beet Breeding Institute in Sweden and with Dr. Ellerton of Bush Johnsons Limited in England. Triploid hybrids are being produced and tested, using our better diploid male-sterile parents in combination with tetraploid pollinators provided by Bernström and Ellerton. This past summer, 3 triploids were produced at Salinas, using the Hilleshög tetraploid H3611, and 24 triploids were produced in England, using 8 of Ellerton's tetraploids and 3 of our male steriles. These triploids are being evaluated in 1959-60 tests in Europe and California.

Three Swedish polyploid varieties were included in 1959 Salinas valley tests. The performance of these polyploids was good but in general did not equal that of our better diploid hybrids. The sugar percentage of the polyploids was not superior to that of the better diploid hybrids.

The addition of Dr. Bayard Hammond to the sugar beet breeding staff at Salinas has made it possible to increase the emphasis on polyploid breeding. Dr. Hammond, who has had extensive experience in cytological work with guayule and other plants, will devote his attention to polyploid breeding and to interspecific hybridization. During the fall months, Dr. Hammond has been making chromosome checks of tetraploids developed at Salinas during the past three years. He has also produced tetraploids in the top cross parent, 663, and in some of the more promising monogerm material.

Descriptions for Varieties Included in Summary Tables

Multigerm hybrids

US H2	(MS of NB1 x NB3) x 663
US H3	(MS of NB1 x NB3) x 586
US H4	(MS of NB1 x NB2) x 366 and 586
US H5A	(MS of NB1 x NB4) x 586
US H5B	(MS of NB1 x NB4) x 663
663H2	(MS of NB5 x NB1) x 663
863H5	7503H1 x 663
887H5	(MS of NB6 x NB5) x 787
787H1	(MS of NB1 x NB4) x 787

Monogerm hybrids

863H8	(MS of 7515 x 7569) x 663
886H1	(MS of 7515 x 7569) x 586
887H1	(MS of 7515 x 7569) x 787
8539H2	(MS of 7515 x 7569) x 8539
863H9	(MS of 7507 x 7569) x 663
886H2	(MS of 7507 x 7569) x 586
863H3	(MS of 7515 x 7507) x 663
887H4	(MS of 7515 x 7507) x 787

Gross sugar yields of bolting-resistant multigerm hybrids and commercial varieties in 1959 California variety tests, expressed in percent of the yield of US 75.

Location	Testing Agency	US 75	US 56/2	US H2	US H3	US H4	US H5A	US H5B	663H2	863H5	887H5	787H1
Coastal Area												
Salinas	USDA	100	91	-	-	-	98	106	107	111	101	105
Salinas	Union	100	88	-	-	-	108	116	110	108	107	112
King City	"	100	106	124	111	-	112	125	121	118	114	120
San Ardo	"	100	96	124	110	-	111	122	117	113	103	116
Betteravia	"	100	97	-	-	-	-	122	115	116	-	107
Oxnard	"	100	102	-	-	107	111	117	118	121	-	115
Gilroy	Spreckels	100	-	-	-	-	-	118	-	-	-	-
King City	"	100	-	-	-	-	-	104	-	-	-	-
Central Valley												
Holland - Test 1	Am.Crystal	100	92	115	90	105	-	-	112	-	-	-
Holland - Test 2	"	100	93	122	103	108	-	-	104	-	-	-
Tracy	Holly	100	103	132	114	117	-	127	-	-	104	-
Tulare	"	100	-	130	114	119	-	125	113	-	128	-
So. San Joaquin	"	100	85	123	105	109	-	-	-	-	-	-
West Side	"	100	-	122	100	101	-	-	-	-	98	-
Ryer Island	"	100	92	115	-	110	-	-	-	-	-	-
Staten Island	"	100	100	116	103	126	-	-	-	-	-	-
Gerber	"	100	94	114	-	104	-	-	-	-	-	-
Hamilton City	"	100	93	115	-	112	-	-	-	-	-	-
Grimes-Colusa	"	100	96	-	-	109	-	-	-	-	-	-
Famosa	Spreckels	100	-	118	-	-	-	-	-	-	-	-
Los Banos	"	100	-	126	-	-	-	-	-	-	-	-
Imperial Valley												
Brawley	USDA	100	107	123	116	-	114	119	121	120	-	-
Imp.Val.-Early	Holly	100	86	119	-	114	-	-	-	-	-	-
" " "	"	100	86	126	-	116	-	-	-	-	-	-
" " "	"	100	83	127	-	121	-	-	-	-	-	-
" " Late	"	100	99	119	-	111	-	-	-	-	-	-
" " "	"	100	97	109	-	111	-	-	-	-	-	-
" " "	"	100	90	109	-	115	-	-	-	-	-	-
" " Inter.	"	100	102	114	-	-	-	119	118	-	104	-

Sucrose percentages of bolting-resistant multigerm hybrids and commercial varieties in 1959 California variety tests, expressed in percent of the yield of US 75.

Location	Testing Agency	US 75	US 56/2	US H2	US H3	US H4	US H5A	US H5B	663H2	863H5	887H5	787H1
Coastal Area												
Salinas	USDA	100	101	-	-	-	99	100	100	101	100	99
Salinas	Union	100	97	-	-	-	103	101	101	99	101	102
King City	"	100	103	100	105	-	103	104	103	101	102	103
San Ardo	"	100	101	103	103	-	103	99	102	100	98	101
Betteravia	"	100	103	-	-	-	-	102	101	98	-	102
Oxnard	"	100	98	-	-	105	102	100	104	103	-	101
Gilroy	Spreckels	100	-	-	-	-	-	101	-	-	-	-
King City	"	100	-	-	-	-	-	103	-	-	-	-
Central Valley												
Holland - Test 1	Am.Crystal	100	101	103	103	106	-	-	104	-	-	-
Holland - Test 2	Am.Crystal	100	104	110	111	112	-	-	112	-	-	-
Tracy	Holly	100	113	106	109	109	-	102	-	-	104	-
Tulare	"	100	-	101	104	107	-	96	101	-	101	-
So.San Joaquin	"	100	101	110	109	108	-	-	-	-	-	-
West Side	"	100	-	104	105	105	-	-	-	-	99	-
Ryer Island	"	100	100	108	-	107	-	-	-	-	-	-
Staten Island	"	100	107	106	108	117	-	-	-	-	-	-
Gerber	"	100	104	105	-	105	-	-	-	-	-	-
Hamilton City	"	100	106	107	-	108	-	-	-	-	-	-
Grimes-Colusa	"	100	106	-	-	111	-	-	-	-	-	-
Famosa	Spreckels	100	-	99	-	-	-	-	-	-	-	-
Los Banos	"	100	-	104	-	-	-	-	-	-	-	-
Imperial Valley												
Brawley	USDA	100	106	104	104	-	101	101	102	101	102	-
Imp.Val.-Early	Holly	100	110	101	105	107	-	-	-	-	-	-
" " "	"	100	109	108	108	109	-	-	-	-	-	-
" " "	"	100	106	105	106	108	-	-	-	-	-	-
" " Late	"	100	108	100	107	105	-	-	-	-	-	-
" " "	"	100	103	97	104	106	-	-	-	-	-	-
" " "	"	100	103	99	102	111	-	-	-	-	-	-
" " Inter.	"	100	106	105	-	-	-	100	101	-	99	-

Gross sugar yields of bolting-resistant monogerm hybrids in 1959 California variety tests, expressed in percent of the yield of US 75.

Location	Testing Agency	US 75	863H8	886H1	887H1	8539H2	863H9	886H2	863H3	887H4
Coastal Area										
Salinas	USDA	100	103	96	100	119	104	-	102	-
Salinas	Union	100	106	95	99	116	107	113	124	-
King City	"	100	119	104	109	-	121	-	111	-
San Ardo	"	100	117	104	110	-	118	-	112	-
Betteravia	"	100	107	95	108	-	109	-	112	-
Oxnard	"	100	119	105	113	-	114	-	-	-
Gilroy	Spreckels	100	109	-	-	-	-	-	-	-
Central Valley										
Tracy	Holly	100	124	106	-	-	129	111	-	117
Tulare	"	100	132	109	122	-	132	118	-	126
So.San Joaquin	"	100	-	95	-	-	-	104	-	-
West Side	"	100	-	-	110	-	-	-	-	-
Ryer Island	"	100	-	101	-	-	-	-	-	-
Imperial Valley										
Brawley	USDA	100	114	100	104	115	115	-	112	108
Imp.Val-Inter.	Holly	100	119	107	112	-	124	117	-	106

Sucrose percentage of bolting-resistant monogerm hybrids in 1959 California variety tests, expressed in percent of the yield of US 75.

Location	Testing Agency	US 75	863H8	886H1	887H1	8539H2	863H9	886H2	863H3	887H4
Coastal Area										
Salinas	USDA	100	104	105	104	102	104	103	102	-
Salinas	Union	100	102	102	101	101	101	104	105	-
King City	"	100	105	108	106	-	103	-	107	-
San Ardo	"	100	104	107	103	-	103	-	104	-
Betteravia	"	100	99	103	101	-	103	-	98	-
Oxnard	"	100	103	104	102	-	102	-	-	-
Gilroy	Spreckels	100	106	-	-	-	-	-	-	-
Central Valley										
Tracy	Holly	100	108	114	-	-	109	111	-	111
Tulare	"	100	105	107	104	-	101	104	-	104
So.San Joaquin	"	100	-	110	-	-	-	109	-	-
West Side	"	100	-	-	104	-	-	-	-	-
Ryer Island	"	100	-	104	-	-	-	-	-	-
Imperial Valley										
Brawley	USDA	100	105	107	103	105	104	106	104	104
Imp.Val.-Inter.	Holly	100	107	109	108	-	103	110	-	104

VARIETY TEST, BRAWLEY, CALIFORNIA, 1958-59.

Location: Southwestern Irrigation Field Station.

Soil type: Holtville Silty clay.

Previous crops: 1955, sugar beets; 1956, flax; 1957, barley and flax.

Fertilizer used: 200 lbs. per acre super phosphate broadcast, and 175 lbs. per acre ammonium sulfate banded, preplant.
300 lbs. ammonium nitrate November 10, 1958.

Thinning date: October 7-10, 1958.

Irrigations: Seven. First irrigation, September 19, 1958 and last March 3, 1959.

Diseases and insects: Curly top and virus yellows were of minor importance in the test plots. The striped cucumber beetle was controlled with an application of 10-percent DDT dust. The cabbage looper was controlled with an application of Cryolite-DDT dust, and a spray application of one-fourth pound parathion and one and one-half pounds DDT per acre.

Experimental design: Randomized block with eight replications and randomized block with two replications. Varieties planted in two-row plots with rows spaced 30 inches apart. Plots 40 feet long.

Sugar samples: From two ten-beet samples by Holly Sugar Corporation, Brawley, California.

Remarks: The test was designed and the results analyzed by the U. S. Agricultural Research Station, Salinas, California.

VARIETY TEST, BRAWLEY, CALIFORNIA

(8 replicated plots of each variety)

Planted Sept. 16 & 17, 1958
Harvested April 14-16, 1959

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Harvest Count
		Pounds	Tons	Percent	Number
863H1	US H2	7,483	21.6	17.3	145
663H2	(MS of NB5 x NB1) x 663	7,408	21.8	17.0	145
863H5	7503H1 x 663	7,305	21.8	16.8	147
863H6	(MS of NB6 x NB5) x 663	7,277	21.2	17.2	153
863H7	(MS of NB1 x NB4) x 663	7,256	21.7	16.7	151
F58-86H7	US H3	7,058	20.6	17.2	136
8539H2	7569H0 x 8539 inbred	7,046	20.2	17.5	148
863H9	7569H1 x 663	7,032	20.4	17.2	154
863H8	7569H0 x 663	6,972	20.0	17.4	153
F57-86H1	(MS of NB1 x NB4) x 586	6,949	20.7	16.8	151
863H3	7507H1 x 663	6,843	19.8	17.3	155
887H4	7507H1 x 787	6,596	19.1	17.3	147
459	US 56/2	6,538	18.6	17.6	135
887H1	7569H0 x 787	6,382	18.7	17.1	148
886H4	7507H1 x 586	6,359	17.8	17.9	155
886H1	7569H0 x 586	6,134	17.3	17.8	152
368	US 75	6,107	18.4	16.6	138
7615H3	(MS of NB1 x NB4) x 7615 inbred	6,078	18.3	16.7	152
General MEAN of all varieties		6,823	19.9	17.2	Beets
S. E. of MEAN		172	0.54	0.16	per
Significant Difference (19:1)		481	1.52	0.45	100'
S. E. Of MEAN in % of MEAN		2.5	2.7	0.9	row

Odds 19:1 = 1.980 x $\sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of freedom	MEAN SQUARES Gross sugar	Tons Beets	Percent Sucrose
Between varieties	17	1,730,707	17.19	1.36
Between replicates	7	236,301	4.17	1.17
Remainder (Error)	119	236,394	2.36	0.21
Total	143			
Calculated F value		7.32**	7.28**	6.61**

**Exceeds the 1% point of significance (F = 2.13)

VARIETY TEST, BRAWLEY, CALIFORNIA - 1959

(2 replicated plots of each variety)

Planted September 16 & 17, 1958
Harvested April 14 - 16, 1959

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Harvest Count
		Pounds	Tons	Percent	Number
F57-509H1R	MS of NB1 x NB3	7,915	22.0	18.0	161
8539H1	7507H1 x 8539 inbred	7,876	22.4	17.6	147
663H1	(MS of NB1 x NB3) x 663	7,696	22.5	17.1	159
F58-509H1	MS of NB1 x NB3	7,686	22.0	17.5	170
8503H2	7569H1 x 8503 inbred	7,478	21.0	17.9	162
F57-509H1Z	MS of NB1 x NB3	7,278	20.7	17.6	144
887H2	7569H1 x 787	7,099	21.1	16.8	152
F58-554H1	MS of NB1 x NB4	7,018	21.2	16.6	145
7615H2	585H0 x 7615 inbred	6,928	19.6	17.7	154
787	Bolt. res. sel. US 75	6,647	20.0	16.6	140
886H3	7515H2 x 586	6,623	18.6	17.9	149
886H2	7569H1 x 586	6,512	18.5	17.6	167
886H5	7547H1 x 586	6,502	19.1	17.1	153
F57-63	Inc. 663	6,470	19.4	16.7	143
887H5	7547H1 x 787	6,390	19.1	16.9	152
8503H3	7507H1 x 8503 inbred	6,375	18.2	17.6	150
466H1	5511H1 x 366	6,154	17.9	17.2	137
8569H1	7515H0 x 7569	4,581	12.2	18.9	149
General MEAN of all varieties		6,846	19.7	17.4	Beets per 100' row
S. E. of MEAN		336	1.02	0.40	
Significant Difference (19:1)		1,003	3.04	N. S.	
S. E. of MEAN in % of MEAN		4.9	5.2	2.3	

Odds 19:1 = 2.110 x $\sqrt{2}$ x Standard Error of Mean

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose
Between varieties	17	1,272,573	11.55	0.70
Between replicates	1	290,521	7.77	1.14
Remainder (Error)	17	226,125	2.07	0.32
Total	35			
Calculated F Value		5.63**	5.58**	N.S.

**Exceeds the 1% point of Significance (F = 2.28)

VARIETY TEST, SALINAS, CALIFORNIA, 1959.

Location: Spence Field of the U. S. Agricultural Research Station.

Soil type: Sandy loam.

Previous crops: Barley cover crop, 1957 and 1958; sugar beets, 1956.

Fertilizer used: 700 lbs. per acre (10-10-5) preplant broadcast.
290 lbs. per acre ammonium sulfate March 24, 1959.
290 lbs. per acre ammonium sulfate May 11, 1959.

Planting date: January 16, 1959.

Thinning date: March 3, 1959.

Harvest date: August 25-26, 1959.

Irrigations: At 7-10 day intervals with sprinkler system.

Diseases and insects: Virus yellows infection was fairly light in 1959 and came in later in the season than usual. An unusually heavy build-up of leaf miner occurred about the middle of June, causing considerable defoliation. The test plot was sprayed with systox for control.

Experimental design: Randomized block with eight replications. Varieties planted in two-row plots with rows spaced 28 inches apart. Plots 50 feet long.

Sugar analysis: From two 10-beet samples per plot by Spreckels Sugar Company, Spreckels, California.

VARIETY TEST, SALINAS, CALIFORNIA, 1959.

(8 replications of each variety)

Planted January 16, 1959
Harvested August 25-26, 1959

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Harvest Count Number
8539H2	7569H0 x 8539 inbred	12,337	38.5	16.0	158
863H5	7503H1 x 663	11,471	36.0	15.9	141
663H2	(MS of NB5 x NB1) x 663	11,113	35.4	15.7	148
863H7	(MS of NB1 x NB4) x 663	11,008	35.1	15.7	142
863H6	(MS of NB6 x NB5) x 663	10,835	34.3	15.8	154
787H1	(MS of NB1 x NB4) x 787	10,826	35.0	15.5	142
863H9	7569H1 x 663	10,802	33.2	16.3	154
863H8	7569H0 x 663	10,631	32.6	16.3	147
863H3	7507H1 x 663	10,566	33.0	16.0	154
887H5	(MS of NB6 x NB5) x 787	10,453	33.3	15.7	146
368	US 75	10,356	32.9	15.7	147
887H1	7569H0 x 787	10,335	31.8	16.3	159
F57-86H1	(MS of NB1 x NB4) x 586	10,155	32.6	15.6	140
8944	Swedish Polyploid H4214	10,074	31.1	16.2	133
886H1	7569H0 x 586	9,924	30.1	16.5	157
7615H3	(MS of NB1 x NB4) x 7615 inbred	9,662	30.7	15.8	143
F58-87	Bolt. res. sel. 368	9,580	31.0	15.5	145
459	US 56/2	9,398	29.7	15.9	145
General MEAN of all varieties		10,528	33.1	15.9	Beets
S. E. of MEAN		211	0.64	0.20	per
Significant Difference (19:1)		592	1.80	0.56	100'
S. E. of MEAN in % of MEAN		2.0	1.9	1.3	row

(Odds 19:1 = 1.98 x $\sqrt{2}$ x Standard Error of MEAN.)

VARIANCE TABLE

Variation due to	Degrees of freedom	MEAN SQUARES Gross sugar	Tons Beets	Percent Sucrose
Between varieties	17	4,100,368	42.3	0.73
Between replications	7	1,212,900	10.1	1.83
Remainder (Error)	119	357,673	3.3	0.32
Total	143			
Calculated F Value		11.46**	12.81**	2.32**

**Exceeds the 1% point of significance (F= 2.09)

VARIETY TEST, SALINAS, CALIFORNIA, 1959.

(4 replications of each variety)

Planted January 16, 1959
Harvested August 25-26, 1959

Variety No.	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beet Count Number
7615H2	585HO x 7615	10,518	32.6	16.2	143
886H2	7569H1 x 586	10,247	31.6	16.2	162
886H4	7507H1 x 586	10,122	30.8	16.5	154
886H6	7503H1 x 586	10,096	32.4	15.6	157
886H5	7547H1 x 586	10,084	31.3	16.1	155
368	US 75	9,556	30.3	15.8	151
1-300	Klein E	9,512	29.2	16.3	140
7508H1	(MS of NB1 x NB4)x7508 inbred	8,751	28.0	15.6	146
7569HO	5515HO x 7569	7,991	23.9	16.7	142

General MEAN of all varieties	9,653	30.0	16.1	Beets per 100' row
SE of MEAN	327	0.93	0.21	
Significant Difference (19:1)	953	2.71	N.S.	
SE of MEAN in % of MEAN	3.4	3.1	1.3	

Odds of 19:1 = 2.06 x $\sqrt{2}$ x Standard Error of the MEAN.

VARIANCE TABLE

Variation due to	Degrees of freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose
Between varieties	8	2,654,505	29.54	0.59
Between replications	3	334,799	4.66	2.75
Remainder (Error)	24	426,917	3.46	0.18
Total	35			
Calculated F Value		6.22**	8.54**	N.S.

**Exceeds the 1% point of significance (F = 3.36)

VARIETY TESTS, HOLLAND, CALIFORNIA, 1959.

By American Crystal Sugar Co.

Test No. 1

Conducted By: Norman Lawlor, Jr.

Location: Holland, California.

Cooperators: S. H. Merwin and Sons.

Date of Planting: January 20, 1959.

Date of Harvest: August 12-13, 1959.

Experimental Design: 12 x 4 Randomized Block.

Size of Plots: 4 rows x 25 feet long, 22" rows.

Harvested Area per Plot for Root Yield: One row, 25 feet long.

Samples for Sucrose Determinations: Two 10-beet samples taken at random.

Stand Counts: Harvested beets counted when weighed.

Diseases: Not a factor.

Seasonal Conditions: Normal.

Reliability of Test: Good

Test No. 2

Conducted by: Norman Lawlor, Jr.

Location: Holland, California.

Cooperators: Sakata Bros.

Date of Planting: January 23, 1959.

Date of Harvest: September 1-2, 1959.

Experimental Design: 12 x 4 Randomized Block.

Size of Plots: 4 rows x 25 feet long, 22 inch rows.

Harvested Area per plot for Root Yield: One row, 25 feet long.

Samples for Sucrose Determinations: Two 10-beet samples taken at Random.

Stand Counts: Harvested beets counted when weighed.

Diseases: Not a factor.

Seasonal Conditions: Normal

Reliability of Test: Good,

VARIETY TEST, HOLLAND, CALIFORNIA, 1959

(4 replicated plots of each variety) By American Crystal Sugar Co.

Test No. 1

Description	Variety	Acre Yield Gross Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beets per 100' of Row Number
German Variety (1956 Seed)	Polybeet	13,536	34.27	19.75	169
(NB1 x NB3)x 51-202	Hybrid #5	12,700	32.76	19.38	172
(NB1 x NB2) x 51-202	Hybrid #4	12,359	31.35	19.71	163
(NB1 x NB3) x 663	663H1	11,958	31.22	19.15	176
(4547HO x NB1) x 663	663H2	11,546	30.01	19.24	163
(NB1 x NB2) x 366	F 56-66H2	10,919	27.68	19.72	173
Am #5 - Non-bolting	58-205	10,531	27.76	18.97	164
Commercial	US 75	10,354	27.88	18.57	155
US 35/2 Sucrose Selection	58-201	10,140	27.16	18.67	165
US 75 Sucrose Selection	57-201	9,666	25.58	18.89	156
Commercial	US 56/2	9,549	25.49	18.73	183
(NB1 x NB3) x 366	F 56-66H3	9,367	24.44	19.16	161
General MEAN		11,052	28.80	19.19	167
S.E. of Variety MEAN		445.3	1.14	.17	6.36
S.E. of MEAN as % of Gen. MEAN		4.03%	3.95%	.87%	3.81%
Diff. Req. for Sig. (Odds 19:1)		1281	3.27	.48	--

VARIANCE TABLE

Source of Variation	Degrees of Freedom	MEAN SQUARES Gross Sugar[a] Pounds	Beets Tons	Sucrose Percent	Beets per 100' row
Blocks	3	---	7.310	.4596	7.333
Varieties	11	---	141.577	.6925	17.000
Error	33	---	19.084	.1113	10.121
Total	47				
Calculated F. Value		---	7.42**	6.22**	NS

**Significant at the 1% point (F = 2.84)

[a] Calculated from the formula:

$$\text{SE lbs. Sugar} = \text{Mean lbs. sugar} \sqrt{\left(\frac{\text{SE lbs. Beets}}{\text{Mean lbs. Beets}}\right)^2 + \left(\frac{\text{SE \% Sugar}}{\text{Mean \% Sugar}}\right)^2}$$

VARIETY TEST, HOLLAND, CALIFORNIA, 1959.

4 replicated plots of each variety) By American Crystal Sugar Co.

Test No. 2

Description	Variety	Acre Yield Gross Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beets per 100' of row Number
German Variety (1956 Seed)	Polybeet	12,518	44.11	14.19	156
(NB1 x NB3) x 663	663H1	12,054	42.64	14.13	140
(NB1 x NB3) x 51-202	Hybrid #5	10,974	40.31	13.61	163
(NB1 x NB2) x 366	F 56-66H2	10,617	37.02	14.34	142
(4547HO x NB1) x 663	663H2	10,271	35.83	14.33	147
(NB1 x NB3) x 366	F 56-66H3	10,166	35.82	14.19	155
(NB1 x NB2) x 51-202	Hybrid #4	10,104	36.65	13.78	127
Am #5 - Non-Bolting	58-205	10,024	36.30	13.81	133
Commercial	US 75	9,864	38.55	12.79	121
US 35/2 Sucrose Selection	58-201	9,830	34.96	14.06	143
US 75 Sucrose Selection	57-201	9,494	34.26	13.86	130
Commercial	US 56/2	9,203	34.49	13.34	144
General MEAN of all varieties in test		10,427	37.58	13.87	142
S.E. of MEAN		593.7	1.80	.43	9.77
S.E. of MEAN as % of Gen. MEAN		5.69%	4.80%	3.07%	6.88%
Diff. Req. for Sig. (Odds 19:1)		1708	5.19	--	--

VARIANCE TABLE

Source of Variation	Degrees of freedom	MEAN SQUARES Pounds Gross Sugar[a]	Beets Tons	Sucrose Percent	Beets per 100' row
Blocks	3	--	48.200	2.7407	3.333
Varieties	11	--	151.663	0.8626	39.927
Error	33	--	47.976	0.7244	23.879
Total	47				
Calculated F. Value			3.16**	NS	NS

** Significant at the 1% point (F = 2.84)

a/ Calculated from the formula:

$$\text{SE lbs. Sugar} = \text{Mean lbs. Sugar} \sqrt{\left(\frac{\text{SE lbs. Beets}}{\text{Mean lbs. Beets}}\right)^2 + \left(\frac{\text{SE \% Sugar}}{\text{Mean \% Sugar}}\right)^2}$$

VARIETY TEST, IMPERIAL VALLEY, CALIFORNIA, 1959

Intermediate date of planting — By Holly Sugar Corporation

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Curly Top Percent	Harvest Count Number
863H9	7569H1 x 663	11,207	38.78	14.45	8.2	138
863H7	(MS of NB1 x NB4) x 663	10,627	37.87	14.03	7.6	140
863H8	7569H0 x 663	10,618	35.21	15.08	6.0	147
663H2	(MS of NB5 x NB1) x 663	10,523	37.16	14.16	4.6	142
886H2	7569H1 x 586	10,441	33.90	15.40	5.5	141
863H1	(MS of NB1 x NB3) x 663	10,194	34.70	14.69	5.2	144
887H2	7569H1 x 787	10,148	35.46	14.31	4.8	139
887H1	7569H0 x 787	9,981	32.77	15.23	4.2	143
887H6	(MS of NB1 x NB3) x 787	9,855	33.36	14.77	3.2	135
886H1	7569H0 x 586	9,598	31.41	15.28	3.0	139
887H4	7507H1 x 787	9,498	32.66	14.54	3.2	137
887H5	(MS of NB6 x NB5) x 787	9,327	33.34	13.99	2.4	138
Lot 7340	US 56/2	9,089	30.66	14.82	5.2	144
Lot 723	US 75	8,934	31.82	14.04	2.9	141
F57-86	Inc. 586	8,531	27.56	15.48	2.7	139
General MEAN of all varieties in test		9,706	33.49	14.51		Beets per 100' row
S. E. of MEAN		343 1/	1.01	0.27		
Significant Difference (19:1)		955	2.81	0.75		
S.E. of MEAN in % of MEAN		3.53	3.01	1.85		

1/ By short cut formula.

VARIANCE TABLE

Source of variation	Degrees of freedom	MEAN SQUARES Tons Beets	MEAN SQUARES Percent Sucrose
Between varieties	29	62.04	3.31
Between replications	8	16.53	4.95
Remainder (Error)	232	9.14	0.70
Total	269		
Calculated F value		6.79**	4.71**

** Exceeds 1% point of significance (F = 1.79)

Cooperator: Nelson Correll

Results extracted from test of 30 varieties.

VARIETY TEST, IMPERIAL VALLEY, CALIFORNIA, 1959.

First planting - September 6, 1958.

By Holly Sugar Corporation

Variety	Description	Gross sugar 1st.har. Pounds	Gross sugar 2nd.har. Pounds	Gross sugar 3rd.har. Pounds	Tons per acre 1st.har. Tons	Tons per acre 2nd.har. Tons	Tons per acre 3rd.har. Tons	Sucrose 1st.har. Percent	Sucrose 2nd.har. Percent	Sucrose 3rd.har. Percent	Curly top 2nd.har. Percent	T.J.P. 3rd.har. Percent
663H1	(MS of NB1 x NB3) x 663	7,084	10,258	10,684	27.82	37.97	41.44	12.73	13.51	12.89	11.0	88.51
F56-66H2	(MS of NB1 x NB2) x 366	6,795	9,435	10,136	25.34	34.61	38.19	13.41	13.63	13.27	8.6	87.56
F56-66H3	US H3	6,509	9,225	9,603	24.54	34.07	36.94	13.26	13.53	13.00	7.9	87.68
Lot 723	US 75	5,958	8,125	8,401	23.68	32.45	34.23	12.58	12.52	12.27	9.6	86.47
Lot 7340	US 56/2	5,128	7,027	6,973	18.61	25.65	26.92	13.78	13.70	12.95	21.3	87.46
General MEAN of all varieties in test		6,355	8,771	8,888	24.48	33.28	35.49	13.00	13.16	12.60		87.09
S. E. of MEAN		142 1/	202	276	0.46	0.65	1.01	0.16	0.16	0.15		0.57
Significant Difference (19:1		401	570	778	1.31	1.83	2.85	0.43	0.46	0.44		N.S.
S. E. Of MEAN in percent of MEAN		2.24	2.30	3.10	1.89	1.94	2.85	1.20	1.24	1.23		0.65

Harvest dates: April 20, 1959, June 8, 1959, July 10, 1959.

Second planting - October 1, 1958.

Variety	Description	Gross sugar 1st.har. Pounds	Gross sugar 2nd.har. Pounds	Gross sugar 3rd.har. Pounds	Tons per acre 1st.har. Tons	Tons per acre 2nd.har. Tons	Tons per acre 3rd.har. Tons	Sucrose 1st.har. Percent	Sucrose 2nd.har. Percent	Sucrose 3rd.har. Percent	Curly top 2nd.har. Percent	T.J.P. 3rd.har. Percent
663H1	(MS of NB1 x NB3) x 663	6,850	9,653	9,634	26.80	37.56	39.39	12.78	12.85	12.33	9.4	87.90
F56-66H2	(MS of NB1 x NB2) x 366	6,413	9,753	10,112	23.95	34.86	36.51	13.39	13.99	13.85	7.3	89.51
F56-66H3	US H3	6,236	9,690	9,117	22.79	35.19	35.84	13.68	13.77	12.72	7.0	88.78
Lot 723	US 75	5,755	8,818	8,800	22.55	33.30	35.23	12.76	13.24	12.49	6.0	88.20
Lot 7340	US 56/2	5,708	8,539	7,954	20.80	31.30	30.81	13.72	13.64	12.91	10.3	88.13
General MEAN of all varieties in test		6,129	9,065	8,908	23.51	34.08	35.41	13.04	13.29	12.56		87.98
S. E. of MEAN		149 1/	230	184	0.50	0.68	0.49	0.15	0.21	0.19		0.45
Significant Difference (19:1)		421	649	518	1.41	1.92	1.38	0.43	0.59	0.54		1.26
S. E. of MEAN in % of MEAN		2.44	2.54	2.06	2.13	1.99	1.38	1.18	1.57	1.53		0.51

Harvest dates: April 22, 1959, June 8, 1959, July 14, 1959.

1/ By short cut formula.

Cooperator: Nelson Correll

Design: 10 x 10 Latin Square.

Plot size: Two-row plots 54 feet x 30 inches. Two rows x 50' harvested.

Results extracted from tests of 10 varieties.

Beet Seed Breeding Department
Holly Sugar Corporation

VARIETY TEST, TRACY, CALIFORNIA, 1959.

By Holly Sugar Corporation

Lot or Variety No.	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Harvest Count Number
L 8285	US H2 (Pollinator mixed)	8,344	28.81	14.48	184
863H9	7569H1 x 663	7,937	26.40	15.03	187
L 8284	US H2 (Pollinator stripped)	7,879	27.14	14.55	173
863H7	(MS of NB1 x NB4) x 663	7,805	27.79	14.04	181
863H8	7569H0 x 663	7,621	25.59	14.89	183
887H6	(MS of NB1 x NB3) x 787	7,432	25.37	14.65	181
887H2	7569H1 x 787	7,218	23.89	15.11	178
887H4	7507H1 x 787	7,161	23.49	15.24	185
L 8301	US H4	7,154	23.93	14.95	179
L 8291	US H3	7,004	23.43	14.95	179
886H2	7569H1 x 586	6,836	22.36	15.29	191
L 513	US 22/3	6,779	24.02	14.11	177
L 405	US 35/2	6,650	22.01	15.11	181
886H1	7569H0 x 586	6,489	20.64	15.72	189
887H5	(MS of NB5 x NB6) x 787	6,383	22.30	14.31	167
L 819	US 56/2	6,302	20.29	15.53	179
L 817	US 75	6,135	22.28	13.77	168
886H5	(MS of NB5 x NB6) x 586	6,084	21.39	14.22	171
F57-86	Bolt. res. US 35	5,824	18.70	15.57	180
General MEAN of all varieties in test		7,168	24.28	14.79	174
S. E. of MEAN		217 1/	0.60	0.23	Beets
Significant Difference (19:1)		603	1.67	0.65	per
S. E. of MEAN in % of MEAN		3.02	2.48	1.58	100' row

1/ By short cut formula.

VARIANCE TABLE

Source of Variation	Degrees of Freedom	MEAN SQUARES Tons Beets	MEAN SQUARES Percent Sucrose
Replication	8	30.02	3.93
Blocks (Elim.Var.)	54	8.82	1.40
Var. (Ignor.Bl.)	41	87.60	5.00
Error (Intra Bl.)	274	2.86	.43
Error (Rand. Bl.)	328	3.84	.59
Var. (Elim. Bl.)	41	77.95	4.21
Total	377		
Calculated F value		27.24**	9.73**

**Exceeds 1% point. F = 1.69

Cooperator: John Paulson
Design: 6 x 7 Rectangular Lattice
Plot size: 2 rows 30" x 53' planted
2 rows x 50' harvested
Planted: 4/3/59. Harvested: 10/28/59

Above results extracted from test of 42 varieties.

VARIETY TEST, SOUTH SAN JOAQUIN, CALIFORNIA, 1959

By Holly Sugar Corporation

Lot or Variety No.	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Harvest Count Number
US H2	(MS of NB1 x NB3) x 663	8053	30.60	13.22	179
SP 55105-0	LSR,CTR sel.	7331	28.28	12.96	180
US H4	(MS of NB1 x NB2) x 366	7085	27.15	13.05	176
61108-0	SP 5450-0 LSR, CTR	7084	26.85	13.19	180
US H3	(MS of NB1 x NB3) x 586	6843	26.10	13.11	176
886H2	7569H1 x 586	6810	25.82	13.19	183
L 405	US 35/2	6631	25.16	13.18	173
L 817	US 75	6523	27.07	12.05	162
886H1	7569H0 x 586	6207	23.44	13.24	175
L 819	US 56/2	5555	22.75	12.21	174
General MEAN of all varieties in test		6859	26.77	12.79	171
S. E. of MEAN		283[1]	1.01	0.21	Beets
Significant Difference (19:1)		796	2.84	0.59	per
S. E. of MEAN in % of MEAN		4.13	3.78	1.64	100' row

[1] By short cut formula.

VARIANCE TABLE

Source of Variation	Degrees of Freedom	MEAN SQUARES Tons Beets	MEAN SQUARES Percent Sucrose
Replications	8	100.41	4.43
Comp a	18	23.95	0.49
Comp b	9	11.07	0.48
Blocks (Elim. Var.)	27	19.66	0.49
Var. (Ignor. Bl.)	15	52.25	3.35
Error (Intra Bl.)	93	7.95	0.38
Error (Rand Bl.)	120	10.58	0.40
Var. (Elim. Bl.)	15	45.61	3.25
Total	143		
Calc. F. value		5.74**	8.58**

**Exceeds 1% point of significance (F = 2.22)

Cooperator: E. V. Bowles
Design: 4 x 4 Triple Lattice - 9 reps.
Plot Size: 2 rows (30") x 53' Planted
2 rows x 50' Harvested
Planted: 2-9-59
Harvested: 9-22-59

The above results were extracted from a test of 16 varieties.

VARIETY TEST, SOUTH SAN JOAQUIN -WEST SIDE, CALIFORNIA, 1959

By Holly Sugar Corporation

Lot or Variety No.	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Bolting Percent	Harvest Count Number
US H2	(MS of NB1 x NB3) x 663	8,244	26.01	15.85	0.45	184
887H1	7569H0 x 787	7,464	23.38	15.96	0.42	193
US H4	(MS of NB1 x NB2) x 366	6,846	21.31	16.06	3.04	179
L 716	US 75	6,768	22.13	15.29	0.55	186
US H3	(MS of NB1 x NB3) x 586	6,759	21.03	16.07	0.39	182
887H5	(MS of NB6 x NB5) x 787	6,656	22.01	15.12	0	182
886H5	(MS of NB6 x NB5) x 586	6,360	20.27	15.69	0.23	182
General MEAN of all varieties in test		6,919	22.28	15.52		183
S. E. of MEAN		204[1]	0.58	0.21		Beets
Significant difference (19:1)		575	1.64	0.59		per
S. E. of MEAN in % of MEAN		2.95	2.61	1.35		100' row

[1]By short cut formula.

VARIANCE TABLE

Source of Variation	Degrees of Freedom	MEAN SQUARES Tons Beets	Percent Sucrose
Varieties	9	35.62	1.96
Replications	9	45.88	6.14
Columns	9	24.87	0.51
Error	72	3.39	0.45
Total	99		
Calculated F. Value		10.52**	4.40**

Cooperator: Frank Diener

Design: 10 x 10 Latin Square

Plot Size: 2 rows (30") x 53' Planted
2 rows x 50' Harvested

Planted: November 1, 1958
Harvested: August 18, 1959

The above results were extracted from a test of 10 varieties.

VARIETY TEST, TULARE, CALIFORNIA, 1959

By Holly Sugar Corporation

Lot or Variety No.	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Bolting Percent	Harvest Count Number
863H8	7569H0 x 663	8,619	30.89	13.95	0.20	171
863H9	7569H1 x 663	8,582	32.05	13.39	0.11	173
US H2	(MS of NB1 x NB3) x 663 (strip)	8,524	31.69	13.45	0.24	202
US H2	(MS of NB1 x NB3) x 663 (mix)	8,466	32.07	13.28	0.54	194
887H5	(MS of NB6 x NB5) x 787	8,336	31.29	13.35	0	183
887H4	7507H1 x 787	8,238	29.78	13.83	0	185
863H7	(MS of NB1 x NB4) x 663	8,167	31.93	12.74	0.35	182
887H2	7569H1 x 787	8,102	30.01	13.50	0.16	185
887H1	7569H0 x 787	7,991	28.95	13.79	0	183
US H4	(MS of NB1 x NB2) x 366	7,761	27.46	14.13	0.64	185
887H6	(MS of NB1 x NB3) x 787	7,751	29.08	13.38	0.66	183
886H2	7569H1 x 586	7,715	27,81	13.81	0.69	183
US H3	(MS of NB1 x NB3) x 586	7,411	27.01	13.72	0.26	164
663H2	(MS of NB5 x NB1) x 663	7,349	27.53	13.32	0	171
886H1	7569H0 x 586	7,087	25.08	14.13	0	185
886H5	(MS of NB6 x NB5) x 586	7,019	26.98	13.10	0	192
L 716	US 75	6,525	24.59	13.24	0.17	192
F57-86	Inc. 586	5,974	21.88	13.65	0.59	187
General MEAN of all varieties in test		7,367	27.60	13.33		177
S. E. of MEAN		327	1.16	0.19		Beets
Significant Difference (19:1)		911	3.23	0.53		per
S. E. of MEAN in % of MEAN		4.43	4.20	1.44		100' row

VARIANCE TABLE

Source of Variation	Degrees of Freedom	MEAN SQUARES Tons Per Acre	MEAN SQUARES Percent Sucrose
Replications	8	1099.04	11.30
Blocks (Elim.Var.)	45	120.49	0.73
Varieties (Ignor.Bl.)	29	116.71	2.65
Varieties (Elim. Bl.)	29	78.85	2.05
Error (Intra Bl.)	187	9.69	0.29
Error (Rand. Bl.)	232	31.18	0.38
Total	269		
Calculated F Value		8.13**	7.10**

**Exceeds 1% point (F = 1.79)

Cooperator: Lester Travis
Design: 5 x 6 Triple Rectangular Lattice
Plot Size: 2 rows (30") x 53' Planted
2 rows x 50' Harvested
Planted: October 23, 1958
Harvested: August 6, 1959

The above results were extracted from a test of 30 varieties.

VARIETY TEST, RYER ISLAND, CALIFORNIA, 1959

By Holly Sugar Corporation

Lot or Variety No.	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Harvest Count Number
US H2	(MS of NB1 x NB3) x 663	6369	21.22	15.01	192
US H4	(MS of NB1 x NB2) x 366	6076	20.39	14.90	195
L 513	US 22/3	5888	21.11	13.95	188
L 7341	663	5876	20.39	14.41	184
886H1	7569HO x 586	5594	19.41	14.41	183
L 817	US 75	5537	19.89	13.92	188
L 704	US 401	5492	21.19	12.96	190
L 819	US 56/2	5086	18.27	13.92	182
General MEAN of all varieties in test		5952	20.80	14.30	189
S. E. of MEAN		268 1/	0.88	0.22	Beets
Significant Difference (19:1)		752	2.47	0.62	per
S. E. of MEAN in % of MEAN		4.50	4.22	1.54	100' row

1/ By short cut formula

VARIANCE TABLE

Source of Variation	Degrees of Freedom	MEAN SQUARES Tons Beets	MEAN SQUARES Percent Sucrose
Replications	8	470.86	2.28
Comp a	18	17.27	0.87
Comp b	9	25.98	0.79
Blocks (Elim. Var.)	27	20.17	0.84
Varieties (Ignor. Bl.)	15	24.15	3.26
Error (Intra Bl.)	93	5.73	0.38
Error (Rand. Bl.)	120	8.98	0.48
Varieties (Elim. Bl.)	15	22.76	2.58
Total	143		
Calculated F. value		3.97**	6.76**

**Exceeds 1% point (F = 2.22)

Cooperator: Jongeneel and Hechtman.
Design: 4 x 4 Triple lattice - 9 reps.
Plot Size: 2 rows (30") x 53' planted.
2 rows x 50' Harvested.
Planted: February 5, 1959.
Harvested: September 24, 1959.

The above results were extracted from a test of 16 varieties.

VARIETY TEST, STATEN ISLAND, CALIFORNIA, 1959

By Holly Sugar Corporation

Lot or Variety No.	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Harvest Count Number
L 8301	US H4	10,240	39.87	12.84	131
L 8285	US H2	9,413	40.57	11.60	139
L 513	US 22/3	9,037	38.69	11.68	126
L 8291	US H3	8,312	35.13	11.83	137
L 819	US 56/2	8,136	34.71	11.72	129
L 817	US 75	8,103	36.90	10.98	133
L 704	US 401	6,949	35.02	9.92	142
General MEAN of all varieties in test		8,803	38.19	11.51	134
S. E. of MEAN		352 1/	0.97	0.35	Beets
Significant Difference (19:1)		988	2.72	1.00	per
S. E. of MEAN in % of MEAN		3.99	2.54	3.08	100' row

1/ By short cut formula.

VARIANCE TABLE

Source of Variation	Degrees of Freedom	MEAN SQUARES Tons Beets	MEAN SQUARES Percent Sucrose
Replication	8	29.35	1.80
Variety	11	63.61	4.63
Error	88	8.46	1.13
Total	107	15.70	1.54
Calculated F value		7.52**	4.08**

** Exceeds 1% point F = 2.48.

Cooperator: M & T Inc.
Design: 3 x 4 Triple Rectangular Lattice (Rand. Block Anal.)
Plot size: 2 rows 20" x 53' planted.
2 rows x 50' harvested
Planted: March 12, 1959.
Harvested: December 3, 1959.

The above results were extracted from a test of 12 varieties.

VARIETY TEST, GERBER, CALIFORNIA, 1959

By Holly Sugar Corporation

Lot or Variety No.	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	LSR[2] Index	Harvest Count Number
US H2	(MS of NB1 x NB3) x 663	7014	27.61	12.70	4.3	170
L 704	US 401	6944	27.00	12.86	2.0	188
L 513	US 22/3	6943	28.04	12.38	5.0	179
US H4	(MS of NB1 x NB2) x 366	6348	25.07	12.66	4.9	175
L 817	US 75	6129	25.43	12.05	4.1	186
L 819	US 56/2	5775	23.05	12.53	5.2	177
General MEAN of all varieties in test		6662	25.75	12.89		177
S. E. of MEAN		211[1]	0.68	0.23		Beets
Significant Difference (19:1)		588	1.89	0.63		per
S. E. of MEAN in % of MEAN		3.17	2.63	1.75		100' row

1/ By short cut formula
2/ Rated from 1 to 10, 1 = Least injury.

VARIANCE TABLE

Source of Variation	Degrees of Freedom	MEAN SQUARES Tons Beets	Percent Sucrose
Replications	8	50.08	13.47
Varieties	19	178.83	2.96
Error	152	4.15	0.45
Total	179		
Calculated F value		43.11**	6.46**

**Exceeds the 1% point of significance (F = 1.97)

Cooperator: Dean Glatz
Design: 4 x 5 Triple Rectangular Lattice, 9 reps, (Rand. Block Anal.)
Plot Size: 2 rows (30") x 53' planted
2 rows x 50' harvested
Planted: March 6, 1959
Harvested: September 17 and 29, 1959

Above results extracted from a test of 20 varieties.

VARIETY TEST, HAMILTON CITY, CALIFORNIA, 1959.

By Holly Sugar Corporation

Lot or Variety No.	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Harvest Count .Number
L 8285	US H2	10,395	35.10	14.81	197
L 8301	US H4	10,105	33.98	14.87	197
L 513	US 22/3	9,239	33.50	13.79	169
L 817	US 75	9,035	32.69	13.82	193
L 819	US 56/2	8,426	28.74	14.66	196
General MEAN of all varieties in test		9,644	33.59	14.35	193
S. E. of MEAN		234	0.68	0.20	
Significant Difference (19:1)		656	1.90	0.55	Beets
S. E. of MEAN in % of MEAN		2.43	2.01	1.36	per 100' row

Cooperator: George Stutz

Design: 3 x 4 Rectangular Lattice (Rand. Block Anal.)

Plot size: 2 rows 30" x 53' planted.
2 rows x 50' harvested
Planted: March 5, 1959.
Harvested: October 20, 1959.

Above results extracted from test of 12 varieties.

VARIETY TEST, GRIMES-COLUSA, CALIFORNIA, 1959.

By Holly Sugar Corporation

Lot or Variety No.	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Harvest Count Number
L 8301	US H4	10,209	34.42	14.83	187
L 817	US 75	9,369	35.14	13.33	189
L 819	US 56/2	9,007	31.83	14.15	195
General MEAN of all varieties in test		10,387	36.86	14.09	190
S. E. of MEAN		216	0.53	0.21	Beets
Significant Difference (19:1)		610	1.49	0.60	per
S. E. of MEAN in % of MEAN		2.08	1.43	1.51	100' row

Cooperator: Charles Yerxa
Design: 10 x 10 Latin square
Plot size: 2 rows 30" x 53' planted
2 rows x 50' harvested
Planted: March 11, 1959
Harvested: November 24, 1959.

Above results extracted from test of 10 varieties.

DATA ON U.S.D.A. VARIETIES TESTED BY SPRECKELS SUGAR COMPANY, DISTRICT I, 1959

Test - Areas:	Spreckels (Late)				Spreckels (Early)				Harry Semas (Gilroy)				Frank Taylor (King City)			
Variety	Lbs. Sug/Ac	Beets T/Ac	% Sugar	Beets 100'	Lbs. Sug/Ac	Beets T/Ac	% Sugar	Beets 100'	Lbs. Sug/Ac	Beets T/Ac	% Sugar	Beets 100'	Lbs. Sug/Ac	Beets T/Ac	% Sugar	Beets 100'
US 33	3,058	11.35	13.5	84												
US 75	2,750	10.57	13.0	81					8,608	28.50	15.1	100	10,664	28.85	18.5	121
US 35/2	2,470	9.18	13.4	83												
US 22	2,494	9.38	13.3	82												
US 15	2,108	8.23	12.6	73												
863H7					7,256	25.70	14.2	107	11,138	36.41	15.3	103	11,088	29.30	19.0	119
663H2					6,900	24.63	14.1	95								
887H1					6,530	23.23	14.1	120								
887H5					6,032	21.79	13.8	112								
886H5					6,012	20.71	14.6	113								
863H8									9,410	29.28	16.0	103				
Planting Date	March 3, 1959				November 26, 1959				April 4, 1959				March 9, 1959			
Harvest Date	August 20, 1959				August 5, 1959				October 29, 1959				October 19, 1959			
General Mean	2,926	10.88	13.5	83	6,620	23.82	13.9	113	10,026	32.74	15.3	103	11,396	30.21	18.9	120
LSD @ P - .05	560	1.98	.45		681	2.39	.60		NS	3.74	0.70		350	NS	NS	
LSD @ P - .01	742	2.62	2.64		908	3.18	0.80		NS	4.98	0.93		467	NS	NS	
S E of Mean	198	0.70	0.16		238	0.84	0.22		--	1.32	0.08		398	-	-	
S E % of Mean	6.76	6.44	1.18		3.598	3.53	1.59			4.05	5.16		3.49			

Results with US Varieties Included in Spreckels Sugar Company Tests in the Central Valley of California and in Nevada. (Data furnished by Spreckels Sugar Co.)

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Harvest Count Number
663H1	(MS of NB1 x NB3) x 663	9,320	33.92	13.76	188
US 75	Check variety	7,900	28.32	13.91	245
General MEAN		8,380	30.64	13.67	262
L.S.D. (5%)		720	2.59	0.51	Per 100'
L.S.D. (1%)		960	3.46	0.68	of row

Location: Famoso, California
Grower: Kern County Land Co.
Varieties tested: 8
Replications: 8

Planted : January 30, 1959
Harvested: August 21, 1959
Plot size: 1 row (30") x 60'

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Harvest Count Number
663H1	(MS of NB1 x NB3) x 663	9,740	35.18	13.80	138
US 75	Check variety	7,740	29.19	13.26	157
General MEAN		9,340	32.42	14.40	162
L.S.D. (5%)		1,400	4.22	0.73	Per 100'
L.S.D. (1%)		1,860	5.60	0.97	of row

Location: Los Banos, California
Grower: Newhall Land and Farming Co.
Varieties tested: 16
Replications: 6

Planted: February 5, 1959
Harvested: November 12, 1959
Plot size: 1 row (30") x 60'

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Harvest Count Number
863H1	(MS of NB1 x NB3) x 663	8,700	31.74	13.72	130
US 75	Check variety	7,560	28.06	13.45	132
General MEAN		8,500	30.89	13.76	137

Location: Fallon, Nevada
Grower: Kent Bros.
Varieties tested: 8
Replications: 8

Planted: March 30, 1959
Harvested: October 23, 1959
Plot size: 1 row (30") x 60'

VARIETY TEST, SALINAS, CALIFORNIA, 1959.

By Union Sugar Division

Grower and location: William H. Ferrasci, Salinas, California.

Soil type: Chualar sandy loam.

Previous crops: Radish seed, 1955; beans, 1956, 1957, and 1958.

Fertilizer used: 500 lbs. per acre 16:20:0 in early March.
400 lbs. ammonium nitrate in May.

Planting date: February 6, 1959.

Thinning date: March 26, 1959.

Harvest date: October 14-15, 1959.

Irrigations: Five; plus six inches of rain in September.

Diseases and insects: Moderate virus yellows infection occurred late in the season. Some root-aphid infestation was noted in the plot with six replications.

Experimental design: Randomized block with eight replications and randomized block with six replications. Varieties planted on double-row beds with 40-inch centers. Plots 60 feet long.

Sugar analysis: From two ten-beet samples per plot by Union Sugar, Betteravia, California.

Remarks: Several plots in the test had poor stands as a result of improper width adjustment of the planter shoes, and due to a crusting problem resulting from a beating rain prior to emergence. The missing feet of row were determined for each plot prior to harvest and the required adjustments made in the plot weight data.

The average yield of the field in which the test plots were located was 28.81 tons of beets per acre with a sucrose content of 14.45 percent.

Seed was furnished, test designed, and results analyzed by U. S. Agricultural Research Station, Salinas, California.

VARIETY TEST, SALINAS, CALIFORNIA, 1959

(8 replications of each variety) By Union Sugar Division

Variety No.	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent
863H7	(MS of NB1 x NB4) x 663	13,680	43.4	15.8
787H1	(MS of NB1 x NB4) x 787	13,130	41.0	16.0
663H2	(MS of NB5 x NB1) x 663	12,933	41.0	15.8
8944	Swedish Polyploid H4214	12,741	38.1	16.6
863H5	7503H1 x 663	12,707	40.7	15.6
F57-86H1	(MS of NB1 x NB4) x 586	12,656	39.1	16.2
863H9	7569H1 x 663	12,539	39.8	15.8
863H8	7569H0 x 663	12,432	38.8	16.0
368	US 75	11,762	37.4	15.7
887H1	7569H0 x 787	11,657	36.8	15.8
886H1	7569H0 x 586	11,187	35.0	16.0
459	US 56/2	10,327	33.7	15.3
General MEAN of all varieties		12,313	38.8	15.9
S.E. of MEAN		423	1.08	0.17
Significant Difference (19:1)		1,190	3.04	0.48
S.E. of MEAN in % of MEAN		3.4	2.8	1.1

Odds 19:1 = 1.991 x $\sqrt{2}$ x Standard Error of MEAN.

VARIANCE TABLE

Variation due to	Degrees of freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose
Between varieties	11	6,829,266	59.97	0.90
Between replications	7	3,195,487	32.66	1.43
Remainder (Error)	77	1,429,427	9.35	0.24
Total	95			
Calculated F value		4.78**	6.41**	3.78**

**Exceeds the 1% point of significance (F = 2.49)

VARIETY TEST, SALINAS, CALIFORNIA, 1959.

(6 replications of each variety) By Union Sugar Division

Variety No.	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent
863H3	7507H1 x 663	11,900	36.8	16.2
7615H2	585H0 x 7615	11,414	36.7	15.5
8539H2	7569H0 x 8539	11,155	35.5	15.7
886H2	7569H1 x 586	10,830	33.5	16.1
886H6	7503H1 x 586	10,306	33.5	15.3
887H5	(MS of NB6 x NB5) x 787	10,287	33.1	15.6
7508H1	(MS of NB1 x NB4) x 7508	10,236	32.6	15.7
886H4	7507H1 x 586	10,080	30.8	16.3
7615H3	(MS of NB1 x NB4) x 7615	9,989	31.3	16.0
1-300	Klein [redacted]	9,621	31.2	15.4
368	US 75	9,581	31.0	15.5
F58-87	Bolt. res. sel. US 75	9,530	30.9	15.4
General MEAN of all varieties		10,411	33.1	15.7
S.E. of MEAN		432	1.18	0.23
Significant Difference (19:1)		1,223	3.35	0.64
S.E. of MEAN in % of MEAN		4.1	3.6	1.5

Odds 19:1 = 2.004 x $\sqrt{2}$ x Standard Error of MEAN.

VARIANCE TABLE

Variation due to	Degrees of freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose
Between varieties	11	3,483,179	29.84	0.68
Between replications	5	16,666,900	160.34	2.52
Remainder (Error)	55	1,117,274	8.38	0.31
Total	71			
Calculated F value		3.12**	3.56**	2.19*

* Exceeds the 5% point of significance (F = 1.97)
**Exceeds the 1% point of significance (F = 2.59)

VARIETY TEST, KING CITY, CALIFORNIA, 1959.

By Union Sugar Division

Grower and location: A. S. Duarte, King City, California.

Soil type: Salinas clay.

Previous crops: 1955, beets; 1956, green lima beans; 1957, carrots; 1958, tomatoes.

Fertilizer used: 400 lbs. per acre 8:24:0 preplant.
500 lbs. per acre ammonium sulfate sidedress as a single application.

Planting date: January 29, 1959.

Thinning date: March 23, 1959.

Harvest date: September 30, 1959.

Irrigations: Five.

Diseases and insects: Virus yellows infection was of minor importance. Insects were not a problem in the tests. Nematode infestation damaged beets in the fourth, fifth, and sixth replications of the larger test.

Experimental design: Randomized block with eight replications and randomized block with four replications. Varieties planted on double-row beds with 40-inch centers. Plots 60 feet long.

Sugar analysis: From two ten-beet samples per plot by Union Sugar, Betteravia, California.

Remarks: The composite yield of the acreage under the Duarte-Union Sugar contract averaged 39.67 tons per acre of beets with a sucrose content of 16.68 percent.

Seed was furnished, test designed, and results analyzed by the U. S. Agricultural Research Station, Salinas, California.

VARIETY TEST, KING CITY, CALIFORNIA, 1959.

(8 replications of each variety) By Union Sugar Division

Variety No.	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Harvest Count
		Pounds	Tons	Percent	Number
863H7	(MS of NB1 x NB4) x 663	12,733	39.1	16.5	156
863H1	US H2	12,679	40.5	15.9	173
863H9	7569H1 x 663	12,370	37.9	16.3	175
663H2	(MS of NB5 x NB1) x 663	12,362	38.2	16.3	169
787H1	(MS of NB1 x NB4) x 787	12,291	37.7	16.4	157
863H8	7569H0 x 663	12,188	36.8	16.7	175
8942	Swedish Polyploid H4202	11,541	35.2	16.4	144
F57-86H1	(MS of NB1 x NB4) x 586	11,459	35.6	16.3	161
F58-86H7	US H3	11,372	34.4	16.7	165
459	US 56/2	10,815	33.4	16.3	159
886H1	7569H0 x 586	10,587	31.1	17.1	173
368	US 75	10,224	32.4	15.9	162
General MEAN of all varieties		11,718	36.0	16.4	Beets
S. E. of MEAN		432	1.40	0.33	per
Significant difference (19:1)		1,216	3.95	N.S.	100'
S. E. of MEAN in % of MEAN		3.7	3.9	2.0	row

Odds 19:1 = 1.991 x $\sqrt{2}$ x Standard Error of MEAN.

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose
Between varieties	11	5,734,337	64.55	0.83
Between replications	7	29,560,251	398.64	10.53
Remainder (Error)	77	1,492,989	15.72	0.87
Total	95			
Calculated F. value		3.84**	4.10**	N.S.

**Exceeds the 1% point of significance (F = 2.48)

VARIETY TEST, KING CITY, CALIFORNIA, 1959.

(4 replications of each variety) By Union Sugar Division

Variety No.	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Harvest Count Number
863H5	7503H1 x 663	14,947	45.3	16.5	128
887H5	(MS of NB6 x NB5) x 787	14,458	43.4	16.7	145
863H3	7507H1 x 663	14,056	40.2	17.5	155
887H1	7569HO x 787	13,779	39.9	17.4	151
368	US 75	12,657	39.1	16.4	137
7615H3	(MS of NB1 x NB4) x 7615	11,071	31.7	17.5	120
General MEAN of all varieties		13,494	39.9	17.0	Beets
S. E. of MEAN		311	1.35	0.25	per
Significant Difference (19:1)		936	4.06	0.77	100'
S. E. of MEAN in % of MEAN		2.3	3.4	1.5	row

Odds 19:1 = 2.131 x $\sqrt{2}$ x Standard Error of MEAN.

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose
Between varieties	5	8,007,670	86.67	1.08
Between replications	3	1,900,879	72.43	4.45
Remainder (Error)	15	385,727	7.28	0.26
Total	23			
Calculated F value		20.76**	11.91**	4.15*

* Exceeds the 5% point of significance (F = 2.90)
**Exceeds the 1% point of significance (F = 4.56)

VARIETY TEST, SAN ARDO, CALIFORNIA, 1959

By Union Sugar Division

Grower and location: Frank Taylor, San Ardo, California.

Soil type: Docos clay loam.

Previous crops: 1955, beans; 1956, onions; 1957, beets; 1958, tomatoes.

Fertilizer used: 300 lbs. per acre 16:20:0 preplant.
500 lbs. per acre ammonium sulfate sidedress as a single application.

Planting date: January 27, 1959.

Thinning date: March 26, 1959.

Harvest date: October 7, 1959.

Irrigations: Six

Diseases and insects: Virus yellows infection was very light in the test plots. Insects were not a problem.

Experimental design: Randomized block with eight replications and randomized block with four replications. Varieties planted on double-row beds with 40-inch centers. Plots 60 feet long.

Sugar analysis: From two ten-beet samples per plot by Union Sugar, Betteravia, California.

Remarks: Seed was furnished, test designed, and results analyzed by U. S. Agricultural Research Station, Salinas, California.

VARIETY TEST, SAN ARDO, CALIFORNIA, 1959.

(8 replications of each variety) By Union Sugar Division

Variety No.	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Harvest Count Number
8943	Swedish Polyploid H 4213	12,852	35.8	18.0	146
863H1	US H2	12,120	32.5	18.7	164
863H7	(MS of NB1 x NB4) x 663	11,852	32.9	18.0	136
863H9	7569H1 x 663	11,507	30.8	18.7	167
663H2	(MS of NB5 x NB1) x 663	11,425	31.1	18.4	149
863H8	7569HO x 663	11,372	30.4	18.8	156
787H1	(MS of NB1 x NB4) x 787	11,249	31.0	18.2	146
F57-86H1	(MS of NB1 x NB4) x 586	10,790	29.1	18.6	154
F58-86H7	US H3	10,721	28.8	18.7	158
886H1	7569HO x 586	10,157	26.3	19.4	153
368	US 75	9,737	26.9	18.1	155
459	US 56/2	9,335	25.6	18.3	145
General MEAN of all varieties		11,093	30.1	18.5	Beets per 100' row
SE of MEAN		328	0.91	0.19	
Significant Difference (19:1)		924	2.56	0.53	
SE of MEAN in % of MEAN		3.0	3.0	1.2	

Odds 19:1 = 1.993 x $\sqrt{2}$ x Standard Error of MEAN.

VARIANCE TABLE

Variation due to	Degrees of freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose
Between varieties	11	8,102,430	69.49	1.27
Between replications	7	5,837,003	75.61	1.94
Remainder (Error)	77	859,563	6.63	0.28
Total	95			
Calculated F Value		9.43**	10.49**	4.50**

**Exceeds the 1% point of significance (F = 2.48)

VARIETY TEST, SAN ARDO, CALIFORNIA, 1959

(4 replications of each variety) By Union Sugar Division

Variety No.	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Harvest Count Number
863H5	7503H1 x 663	12,683	36.5	17.4	167
863H3	7507H1 x 663	12,622	34.9	18.1	158
887H1	7569H0 x 787	12,376	34.7	17.9	158
887H5	(MS of NB6 x NB5) x 787	11,587	33.8	17.1	173
368	US 75	11,240	32.3	17.4	159
7615H3	(MS of NB1 x NB4) x 7615	10,246	28.3	18.2	150
General MEAN of all varieties		11,792	33.4	17.7	Beets per 100' row
S. E. of MEAN		324	0.92	0.28	
Significant Difference (19:1)		976	2.77	N.S.	
S. E. of MEAN in % of MEAN		2.8	2.8	1.6	

Odds 19:1 = 2.131 x $\sqrt{2}$ x Standard Error of MEAN.

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose
Between varieties	5	3,648,120	32.52	0.69
Between replications	3	397,097	11.10	0.94
Remainder (Error)	15	419,769	3.38	0.30
Total	23			
Calculated F value		8.69**	9.62**	N. S.

**Exceeds the 1% point of significance (F = 4.56)

VARIETY TEST, BETTERAVIA, CALIFORNIA, 1959.

By Union Sugar Division

Grower and location: Pezzoni and Silva, Pezzoni Ranch, Guadalupe, California.

Soil type: Yolo sandy loam.

Previous crops: 1955 and 1956, beans; 1957 and 1958, lettuce-cauliflower.

Fertilizer used: Preplant - none.
500 lbs. per acre ammonium sulfate prior to thinning.
600 lbs. per acre ammonium sulfate in May.

Planting date: January 21, 1959.

Thinning date: March 10, 1959.

Harvest date: September 2, 1959.

Irrigations: Five.

Diseases and insects: Virus yellows infection appeared to be very light on inspection of the test plot in early May and again on July 22, 1959. By the latter date, however, yellows symptoms were partially obscured by a severe rust infection. The varieties were rated for rust damage and the ratings are reported in the summary table. Essentially, no evidence of rust infection was present at harvest. Nematode infestation was fairly uniform throughout the test plot but caused only light damage to the beets.

Experimental design: Randomized block with eight replications. Varieties planted on double-row beds with 40-inch centers. Plots 60 feet long.

Sugar analysis: From two ten-beet samples per plot by Union Sugar, Betteravia, California.

Remarks: The field in which the test plot was located yielded, on the average, thirty-two tons per acre of beets with a sucrose content of 14.96 percent.

Seed was furnished, test designed and results analyzed by U. S. Agricultural Research Station, Salinas, California.

VARIETY TEST, BETTERAVIA, CALIFORNIA, 1959.

(8 replications of each variety) By Union Sugar Division

Variety No.	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Infection Rating	Harvest Count Number
863H7	(MS of NB1 x NB4) x 663	11,196	37.7	14.9	2.9[1/]	138
863H5	7503H1 x 663	10,637	37.4	14.3	2.3	137
663H2	(MS of NB5 x NB1) x 663	10,577	35.7	14.8	3.9	142
863H3	7507H1 x 663	10,288	36.0	14.3	3.1	148
863H9	7569H1 x 663	9,959	33.0	15.1	4.6	143.
887H1	7569H0 x 787	9,913	33.5	14.8	5.4	147
787H1	(MS of NB1 x NB4) x 787	9,816	32.9	14.9	4.9	138
863H8	7569H0 x 663	9,803	33.9	14.5	3.9	144
368	US 75	9,170	31.4	14.6	4.3	133
7615H3	(MS of NB1 x NB4) x 7615 inbred	9,149	30.6	15.0	7.3	141
459	US 56/2	8,857	29.5	15.0	2.5	135
886H1	7569H0 x 586	8,741	28.9	15.1	5.3	145
General MEAN of all varieties		9,842	33.4	14.8	4.2	Beets per 100' row
S. E. of MEAN		208	0.64	0.17	0.34	
Significant Difference (19:1)		586	1.81	0.47	0.95	
S. E. of MEAN in % of MEAN		2.1	1.9	1.1	8.1	

Odds 19:1 = 1.991 x $\sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of freedom	MEAN SQUARES Gross sugar	Tons Beets	Percent Sucrose	Rust Infection
Between varieties	11	4,612,445	68.30	0.71	16.18
Between replications	7	363,568	4.58	1.07	1.43
Remainder (Error)	77	346,543	3.30	0.22	0.92
Total	95				
Calculated F value		13.31**	20.70**	3.20**	17.59**

**Exceeds the 1% point of significance (F = 2.49)

1/ Rust evaluations based on scale of 1 to 10.(1 = Lowest and 10 = highest incidence.)

VARIETY TEST, OXNARD, CALIFORNIA, 1959.

By Union Sugar Division.

Grower and location: J. P. Bauer, Oxnard, California.

Soil type: Sandy loam.

Previous crops: 1956, sugar beets; 1957 and 1958, lima beans.

Fertilizer used: 150 lbs. nitrogen preplant. Sidedress, none.

Planting date: January 25, 1959.

Thinning date: April 4, 1959.

Harvest date: September 3, 1959.

Irrigations: Planting irrigated up in late February. Planting received three additional irrigations.

Diseases and insects: Some virus yellows infection evident in early May and by late July the infection appeared to be 100 percent. Rootknot nematode damage occurred in scattered small areas of the plot. Damage was very severe in a section of the field adjoining the area in which the test plot was located. Insects were not a factor in this test.

Fumigation for nematode: None.

Experimental design: Randomized block with eight replications. Varieties planted on double-row beds with 40-inch centers. Plots 60 feet long.

Sugar analysis: From two ten-beet samples per plot by Union Sugar, Betteravia, California.

Remarks: Seed was furnished, test designed, and results analyzed by U. S. Agricultural Research Station, Salinas, California.

VARIETY TEST, OXNARD, CALIFORNIA, 1959

(8 replications of each variety) By Union Sugar Division

Variety No.	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Harvest Count
		Pounds	Tons	Percent	Number
863H5	7503H1 x 663	13,419	35.2	19.1	127
863H8	7569H0 x 663	13,141	34.3	19.2	131
663H2	(MS of NB5 x NB1) x 663	13,064	33.8	19.3	119
863H7	(MS of NB1 x NB4) x 663	12,951	34.9	18.6	125
787H1	(MS of NB1 x NB4) x 787	12,758	34.0	18.8	132
863H9	7569H1 x 663	12,649	33.3	19.0	137
887H1	7569H0 x 787	12,482	32.8	19.0	136
F57-86H1	(MS of NB1 x NB4) x 586	12,236	32.3	18.9	133
F56-66H2	(MS of NB1 x NB2) x 366	11,793	30.3	19.5	101
886H1	7569H0 x 586	11,582	29.9	19.4	123
459	US 56/2	11,356	31.0	18.3	124
368	US 75	11,060	29.6	18.6	125
General MEAN of all varieties		12,374	32.6	19.0	Beets per 100' row
SE of MEAN		330	0.78	0.23	
Significant Difference (19:1)		928	2.2	0.65	
SE of MEAN in % of MEAN		2.7	2.4	1.2	

Odds 19:1 = 1.991 x $\sqrt{2}$ x Standard Error of MEAN.

VARIANCE TABLE

Variation due to	Degrees of freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose
Between varieties	11	4,706,778	31.08	0.97
Between replications	7	4,495,756	50.28	2.66
Remainder (Error)	77	870,203	4.86	0.43
Total	95			
Calculated F value		5.41**	6.40**	2.24*

* Exceeds the 5% level of significance (F = 1.92)
**Exceeds the 1% level of significance (F = 2.49)

PURITY ANALYSIS, OXNARD, BETTERAVIA, SAN ARDO VARIETY TESTS, 1959

By Union Sugar Division.

Variety No.	Description	Thin juice purity Oxnard Percent	Betteravia Percent	San Ardo Test 1 Percent	San Ardo Test 2 Percent
863H5	7503H1 x 663	91.5	90.4		93.3
863H8	7569H0 x 663	91.3	90.7	93.3	
663H2	(MS of NB5 x NB1) x 663	91.8	91.1	93.2	
863H7	(MS of NB1 x NB4) x 663	91.1	90.4	93.0	
787H1	(MS of NB1 x NB4) x 787	91.2	90.4	93.4	
863H9	7569H1 x 663	91.4	90.9	94.1	
887H1	7569H0 x 787	91.7	90.5		92.8
F57-86H1	(MS of NB1 x NB4) x 586	91.1		93.4	
F56-66H2	(MS of NB1 x NB2) x 366	91.4			
886H1	7569H0 x 586	91.9	90.4	93.8	
459	US 56/2	90.9	91.2	93.8	
368	US 75	91.1	89.7	93.5	93.3
863H3	7507H1 x 663		90.4		94.1
7615H3	(MS of NB1 x NB4) x 7615		90.6		92.5
863H1	US H2			93.6	
F58-86H7	US H3			93.6	
8943	Swedish Polyploid H 4213			92.1	
887H5	(MS of NB6 x NB5) x 787				92.4
General MEAN of all varieties in test		91.4	90.5	93.4	92.9
S. E. of MEAN		0.29	0.36	0.31	0.31
Significant Difference (19:1)		NS	NS	0.86	NS
S. E. of MEAN in % of MEAN		0.31	0.39	0.33	0.33

Odds (19:1) = 1.991 x $\sqrt{2}$ x Standard Error of MEAN
Odds (19:1) = 2.131 x $\sqrt{2}$ x Standard Error of MEAN for San Ardo Test 2.

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES Thin juice purity Oxnard Percent	Betteravia Percent	San Ardo 1 Percent	San Ardo 2 Percent
Between varieties	11	0.75	1.31	1.95	0.75 1/
Between replications	7	1.03	3.72	1.82	2.31
Remainder (Error)	77	0.65	1.01	0.75	0.75
Total	95				
Calculated F Value		NS	NS	2.60**	NS

** Exceeds 1% point of significance (F = 1.92)

1/ Degrees of freedom for San Ardo Test 2 are: Varieties 5
Replications 3
Error 15
Total 23

MALE STERILITY IN THE SUGAR BEET INDUCED BY SODIUM 2, 3-DICHLOROISOBUTYRATE

I. O. Skoyen

Field and greenhouse tests were continued in 1959 on pollen sterility of sugar beet induced by the gametocide sodium 2, 3-dichloroisobutyrate, referred to as FW 450.

Materials and Procedures

Field tests were made with plants of the self-fertile inbred, 8539, transplanted at Salinas from an Oregon planting on March 12, 1959. Two and three spray applications to near runoff were made at about 10-day intervals with 0.2-, 0.3-and 0.4-percent aqueous solutions of FW 450. Treatment was made initially when plants were in the early bud stage and was begun April 21, 1959.

The effectiveness of FW 450 as a gametocide was determined by making bagged crosses between treated green hypocotyl plants and red hypocotyl, non-treated plants. Floral branches of treated plants were also left exposed to permit open pollination. Several bags were placed on floral branches of treated plants to evaluate selfing and pollen production. Pollen production was further evaluated by making crosses between plants of a male sterile and treated plants of 8539.

Greenhouse tests of FW 450 were made with plants of the self-fertile inbreds NB4, NB5, and NB6 which had been induced in the coldroom. Applications of FW 450 at concentrations of 0.2, 0.3 and 0.4 percent were begun on September 17, 1959, and were made to runoff. All plants received three applications at one-to two-week intervals.

Results

Results of field tests, summarized in table 1, show that seed yield was reduced between 40 and 50 percent on treated plants of the 8539 inbred and was higher for the 0.3 and 0.4 than for the 0.2 percent concentration of FW 450. Percentage germination was reduced from about 10 to nearly 20 percent with the 0.3 percent treatment showing the highest germination and the 0.4 percent treatment the lowest. Although seed yield was reduced, the reduction was probably greater than would have been obtained on treated plants left fully exposed to open pollination,because the portions of plants bagged to insure selfing generally yielded only small amounts of seed. Bagged portions of check plants set seed as well under the bag as on exposed portions.

Table 1 also includes results of pollen production tests of treated 8539 plants. Seed set was obtained with 56.7, 55.6, and 52.0 percent of the crosses between a male sterile and plants of 8539 given treatments of 0.2, 0.3 and 0.4 percent, respectively. Data presented in table 2 show that seed set was obtained on a majority of the crosses during the 36- to 60-day interval for the 0.2 percent treatment, during the 40-to 60-day interval for the 0.3 percent treatment, and during the 45- to 60-day interval for the 0.4 percent treatment. The percent of crosses which set seed was 72.7 for 0.2 percent, 85.7 for 0.3 percent and 82.0 for the 0.4 percent treatment. For the 0 to 35, 0 to 40 and 0 to 45 day intervals,

the percent of crosses which set seed was 52.9 for 0.2, 40.0 for 0.3 and 23.0 for the 0.4 percent treatment. This indicates that reversion to pollen production was rapid in the 40-to 60-day interval for all levels of treatment and was probably near normal by the 56-to 60-day interval. Results presented in table 3 show that hybridization in crosses between treated plants and red hypocotyl, non-treated plants was in general fairly high during the period of 15 to 40 days following final treatment with FW 450. However, only slight hybridization occurred in crosses made during the 56-to 60-day interval and is a further indication that treated plants had largely reverted to production of viable pollen by that time.

Additional results presented in Table 1 show that viable seed was produced in 64.7, 60.0 and 76.9 percent of the crosses between the male sterile and plants of 8539 treated with 0.2, 0.3 and 0.4 percent FW 450. Germination was 43.6, 38.6, and 59.7 percent for the respective FW 450 treatments as compared to 90.0 percent for crosses with untreated plants.

It perhaps bears mentioning that, at Salinas, climatic conditions during the summer tend to extend flowering and seed production almost indefinitely. Plants which begin flowering in May usually are still flowering and setting seed at harvest in late July or early August. Consequently, it is a distinct possibility that under climatic conditions which produce a determinate type flowering in beets, the percentage of hybrids produced in crosses between treated plants and red-hypocotyl plants would be higher than the results indicate. A portion of the seed was ripe on each plant at harvest, but seed in immature stages of development was also present.

In the greenhouse tests with FW 450, treated plants became sterile more rapidly than was observed under field conditions. This held for all three inbreds, NB4, NB5, and NB6, over the 0.2, 0.3 and 0.4 percent concentrations of FW 450. Phytotoxicity was also more pronounced in the greenhouse tests.

The 0.2 percent treatment when applied initially to plants in an early bud stage of flowering produced sterile anthers in open and opening flowers within 15 days after the first application of FW 450. Plants were still pollen sterile 50 days after initial treatment. Plants of NB5 and NB6 showed signs of return to normal flowering at 30-35 days, particularly with respect to the reduced thickening of sepals and bracts and opening of the sepals to expose the stigma, but flowers were smaller. Thickening of sepals developed at about 20 days, and, together with failure of sepals to open normally, produced a flower which, on casual inspection, appeared closed. Anthers also showed a return to normal color, ranging from light brown and light yellow to white, but were much reduced in size and appeared empty at 50 days.

Treating plants of NB4, NB5, and NB6 with a 0.3 percent concentration of FW 450 at an early bud stage resulted in pollen sterility of the first open flowers. Flowers began to open 20 to 25 days after initial applications of FW 450. Anthers of the first open flowers ranged from light yellow to black. Anthers which appeared normal in size and color in early flowers failed to dehisce and frequently turned a yellow-brown just before or shortly after the flowers opened. Anthers were still sterile 50 days after initial treatment. A tendency toward the return to normal anthers was apparent at 40 days in the NB5 and NB6 inbreds. Flowers opening about 40 days after initial treatment

showed more normal sepals and opening of the flowers. Reversion to normal flowering was not particularly apparent after 45 days for the NB4 inbred. Flower size was reduced for both NB5 and NB6. Phytotoxic effects from FW 450 were slightly more severe for the 0.3 percent than for the 0.2 percent treatment. Applications of a 0.4 percent concentration of FW 450 to plants of NB4, NB5 and NB6 in early bud produced effective sterility within 20 days of initial treatment. Anthers of early flowers ranged from light yellow to brown or black. Nearly normal appearing anthers failed to dehisce. Slightly more severe damage to flower parts, other than the anthers, was observed for this treatment. Reversion toward normal flower structure was observed by the 35th day for NB5, by 50 days for NB6, and not at all for NB4. Evidence of the chlorosis phase of phytotoxicity was present within ten days for NB4 and NB6 and within 15 days for NB5. Severity of phytotoxicity progressed through about 30 days, or approximately the period during which plants were treated with three applications of FW 450.

Summary

The results of the field tests indicate that treating plants of 8539 inbred with the gametocide, FW 450, reduces both seed yield and germination percentage of the seed. The period of maximum sterility varies but probably falls within a period of 15 to 45 days following final treatment with FW 450. Pollen sterility is obtained in the earliest flowers when treatment with FW 450 is begun at an early bud stage of flowering.

Observations of FW 450 tests under greenhouse conditions indicate that the development of sterility in treated plants occurs in a shorter period of time than in the field. Phytotoxicity is also more severe under greenhouse conditions. The greenhouse tests, however, were run during the warmest season of the year at Salinas and the plants were frequently exposed to high daytime temperatures; whereas, field conditions were generally considerably cooler both day and night. Comparing initiation of flowering, degree and duration of sterility, and phytotoxicity in the two tests indicates that FW 450 is probably equally effective under both field and greenhouse conditions but that higher temperatures accelerate the response of sugar beet to FW 450.

Table 1.--Summary of results of treating plants of 8539 inbred with three concentrations of FW 450.

	Concentration			
	Check	0.2%	0.3%	0.4%
Seed yield (Ave.)	53.8 g.	31.4 g.	30.2 g.	28.2 g.
" " in % of check	100	58.3	56.1	52.4
Percent germination (Ave.)	89.8	71.7	81.3	70.1
Male sterile x FW 450 treated plants				
Plants crossed	-	11	12	9
No. of crosses	-	30	18	25
% of crosses setting seed	-	56.7	55.6	52.0
% of crosses with viable seed	-	64.7	60.0	76.9
% germination	90	43.6	38.6	59.7

Table 2.--Seed yield of crosses made at various periods following treatment between plants of a male sterile and plants of 8539 inbred treated with FW 450.

Plant No.	Conc. FW 450 %	No. of appl.	Days following last treatment 0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60
9806	0.2	2						0					10 s.	
9809		3			0						0			
9811		3							0					
9810		3						0						
9848		2			0					0.5 g.				2.5 g.
9827		2			0			0	16 s.					3.0 g.
9828		2								0		0.5		3.5 g.
9829		3							4.0					
9830		3	0.5 g.				0.5 g.	0.5 g.			0	7 s.		
9831		3	3 s.[1]			0	1.0 g.	10 s.				4 s.		
9845		3			5 s.									
9812	0.3	2						0			-	35 s.		
9813		2			0									
9814		2						0						
9815		3							25 s.			1.0 g.		
9817		3					0							
9832		2									0			0.5 g.
9833		2												2.5 g.
9835		3								2 s.	3.0 g.			
9836		3									1.0 g.			
9837		3						0						
9850		2					3 s.	25 s.						
9844		3			0									
9818	0.4	2			0				13 s.		0			25 s.
9819		2									0	0		1.0 g.
9820		3	0				0	0	0					0
9821		3					0							
9822		3					0							
9838		2										1.0 g.		5.5 g.
9839		2								1 s.		53. s.		1.5 g.
9841		2			0									1.0 g.
9849		2								7 s.		7 s.		2.5 g.

[1] s = seed or seeds

Table 3.--Percent hybridization in crosses made at various periods following treatment, between plants of 8539 treated with FW 450 and non-treated, red-hypocotyl plants used as pollen parents.

Plant No.	Conc. FW 450 %	No. of appl.	Days following last treatment 0-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60
9806	0.2	2					83.0						
9808		2							37.5				
9811		3							16.9				
9810		3				49.0							
9848		2					64.0						0.4
9827		2					12.2						0.0
9828		2							16.0[1]				0.0
9830		3			23.0[1]								0.0
9831		3			16.0[1]	75.0							0.0
9812	0.3	2			74.0								
9832		2							36.0[1]				0.0
9834		2							0.0				
9835		3							68.0				
9836		3							16.0				
9838	0.4	2											0.0
9839		2							19.6				0.0
9841		2					95[1]		2.3				
9842		2							74.0				
9849		2							0.0				0.5

[1] Purity of pollen parents for red hypocotyl not known, therefore, the percent hybridization may be higher than that shown, but not lower.

P A R T VII

PRODUCTION OF BASIC BREEDING MATERIAL

and

DEVELOPMENT OF BREEDING PROCEDURES

Foundation Project 25

LeRoy Powers R. E. Hecker

PROGRESS REPORT TO THE BEET SUGAR DEVELOPMENT FOUNDATION ON THE GENETIC AND PLANT BREEDING PHASES OF PROJECT NUMBER 25 1/

By LeRoy Powers and Richard J. Hecker

Population Genetic Studies at One Level of Soil Fertility, 1958 Data

Eight populations were included in the population genetic studies at one level of soil fertility conducted in 1958. The populations are as follows:

A54-1	57-7991 CMS
Sel. A54-1 synthetic	F_1 hybrid (52-430 X 52-414)
Sel. A54-1 hi	55-8035 inbred
Sel. A54-1 lo	A58-1

A54-1 is the commercial variety from which the three selections were made. Sel. A54-1 synthetic resulted from selection from small units (Powers, 1957). Selecting against the mean of units composed of 288 plants, 32 from a potential of 11,520 were saved and asexually propagated. By a polycross test these were reduced to 10. These 10 asexually propagated plants were interpollinated in the greenhouse to produce Sel. A54-1 synthetic. Sel. A54-1 hi was selected from small units having a high level of soil fertility and Sel. A54-1 lo from small units having a low level of soil fertility. Forty roots of each were grown in isolation to obtain the seed used to produce the two populations included in this study. For further details see Powers et al. 1958 and "Sugar Beet Research 1958 Report", CR-4-59. The population designated as 57-7991 CMS was bulked from cytoplasmic male sterile plants pollinated by plants of Sel. A54-1 hi and Sel. A54-1 lo. The F_1 hybrid resulted from crossing inbreds

1/ The breeding and genetic phases of project 25 are cooperative with the Agronomy Department of the Colorado State University Agricultural Experiment Station.

52-430 and 52-414. Inbred 52-414 exhibited somewhat greater variability than the more uniform inbreds of the late Mr. Deming. Inbred 55-8035 from observation in the inbred plots of previous years appeared to be uniform. Seed of A58-1 was obtained from the American Crystal Sugar Company.

The analyses of variance for percentage sucrose and weight per root are given in table 1. The analyses show that there are significant differences between both populations and replications. For percentage sucrose the interaction of replications X populations is significant. In all cases the odds against these differences being due to chance are greater than 99:1. It can be seen that the mean square for remainder for weight per root is significantly larger than the mean square for replications X populations. This may be due to the fact that the remainder includes the genetic variance for populations. Only 25 percent of the genetic variances for populations would be expected to be included in the mean square for replications X populations. These findings make it seem as though further study of the data from this population genetic study would provide valuable information.

[illegible] populations and replications. [illegible] the inter-
[illegible] replications X populations is significant. In all cases the odds
against these differences being due to chance are greater than 99:1. It can
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[illegible] of the [illegible] differences for populations would be expected to
[illegible] mean square for replications X populations. These findings
[illegible] further study of the data.

Table 1. Analysis of variance for percentage sucrose and weight per root.

Source of variation	Smaller M. S. 1/	Mean square		D. F. 1/	F value 2/		F value at level of	
		Sucrose	Weight per root		Sucrose	Weight per root	1%	5%
		%	Lbs.		%	Lbs		
Replications		8.3772	3.6988	79	2.31a	1.52a	1.47	1.32
Populations		524.2948	138.4636	7	144.66a	56.97a	2.69	2.03
R X P	a	3.6242	2.4306	553	1.56b		1.19	1.13
Remainder, (P X L, R X L, R X P X L, and L)	b	2.3181	3.5067	1920		1.44a	1.19	1.13

1. M. S. designates mean square and D. F. degrees of freedom.

2. The letter after the F value indicates the smaller mean square used in calculating F.

Means and Variances for Percentage Sucrose and Weight per Root

The means for percentage sucrose, weight per root, and sugar per root are given in table 2. Sel. A54-1 synthetic represents an increase over A54-1 of 4.1 percent in percent sucrose and 5.1 percent in weight per root. The increase in percentage sucrose is 0.66 percent and is statistically significant at the 5-percent level. The odds against the difference of 0.16 pounds per root being due to chance are about 5:1 for this test. However, in 1957 the progeny of the parental plants in a polycross test gave a 7.1 percent increase in weight of roots. This increase is significant at the 5-percent level. Taking into consideration the original plants selected in 1956, this material has shown an increase in weight of root in the tests conducted in 1956, 1957, and 1958.

Sel. A54-1 hi shows a 0.6 percent increase in percentage sucrose and a 4.8 percent increase in weight per root. Neither of these increases is significant at the 5-percent level. However, in the polycross test also conducted in 1958 this material showed an increase of 6.1 percent in weight per root, which is statistically significant at the 5-percent level. In the polycross test, Sel. A54-1 hi showed a decrease of 0.3 percent in sucrose but this is not statistically significant. Considering the data from the two tests, Sel. A54-1 hi seems equal to A54-1 in percentage sucrose but has greater weight per root. It was derived from A54-1.

Table 2. Means for percentage sucrose, weight per root, and sugar per root.

Population	Percentage sucrose		Weight per root		Sugar per root	
	Mean	Percent of A54-1	Mean	Percent of A54-1	Mean	Percent of A54-1
	%	%	Lbs.	%	Lbs.	%
A54-1	16.10	100.0	3.13	100.0	0.5039	100.0
Sel. A54-1 synthetic	16.76*	104.1	3.29	105.1	0.5514*	109.4
Sel. A54-1 hi	16.20	100.6	3.28	104.8	0.5314	105.5
Sel. A54-1 lo	16.54*	102.7	3.04	97.1	0.5028	99.8
57-7991 CMS	15.32*	95.2	3.71*	118.5	0.5684*	112.8
F_1 hybrid	15.24*	94.7	2.55*	81.5	0.3886*	77.1
55-8035 inbred	13.34*	82.9	1.63*	52.1	0.2174*	43.1
A58-1	13.70*	85.1	2.38*	76.0	0.3261*	64.7

* Odds are greater than 19:1 against these values being chance deviations from those of A54-1.

Sel. A54-1 lo shows a significant increase in percentage sucrose and a 0.09 pounds per plant decrease in weight per root. However, this decrease in weight per root is not statistically significant at the 5-percent level and hence is readily accounted for by chance fluctuation. Population 57-7991 CMS has lower percentage sucrose and an increase of 18.5 percent in weight per root. These differences are significant at the 5-percent level.

The F_1 hybrid, 55-8035, and A58-1 show a significant decrease over A54-1 in both percentage sucrose and weight per root.

Variances for percentage sucrose

The obtained and residual within-plot variances, and standard errors for populations are listed in table 3. The character is percentage sucrose.

The variance of inbred 55-8035 is used as a measure of the environmental variance. The degrees of freedom for each population are 240, and the F value at the 1-percent level is 1.39 and at the 5-percent level is 1.26. The obtained standard errors are calculated from the obtained variances of table 3 and are used later to test normalcy of the obtained frequency distributions. It should be noted that the greater portion of the residual variances are genetic. For sake of clarity, the residual variance from now on will be referred to as the genetic variance.

Table 3. Obtained and residual within plot variances, F values, and obtained standard errors for populations, the character being percentage sucrose.

Population	Variance		F value 2/		Obtained standard error 4/
	Obtained	Residual	A54-1 3/	55-8035	
A54-1	2.3283	1.1695		2.01	1.5259
Sel. A54-1 synthetic	1.9251	0.7663	1.20-	1.66	1.3875
Sel. A54-1 hi	2.8614	1.7026	1.23	2.47	1.6916
Sel. A54-1 lo	1.7412	0.5824	1.34-	1.50	1.3195
57-7991 CMS	2.9543	1.7955	1.27	2.55	1.7188
F_1 hybrid	1.8533	0.6945	1.26-	1.60	1.3614
55-8035 inbred	1.1588 1/		2.01-		1.0765
A58-1	3.7223	2.5635	1.60	3.21	1.9293

1/ The obtained variance for 55-8035 inbred is used as an estimate of the environmental variance.

2/ The degrees of freedom for each population are 240 and the F value at the 1% level is 1.39 and at the 5% level is 1.26.

3/ The minus sign after the F value indicates that the obtained variance is less than the obtained variance of A54-1 with which it is compared.

4/ These are the standard errors calculated from the obtained variances.

The genetic variances for Sel. A54-1 synthetic and Sel. A54-1 lo are less than the genetic variance for A54-1, the population from which they were derived. The odds are rather great that these differences are not due to chance. These populations were found to average significantly higher in percentage sucrose than A54-1. Apparently the genetic variability of these populations has been reduced compared with the population from which they were derived. Also, the genetic variability of the F_1 hybrid and inbred 55-8035 is significantly lower than that of A54-1. Undoubtedly this is due to the fact that the F_1 hybrid resulted from crossing two inbreds (52-430 X 52-414) and that comparatively 55-8035 is a relatively homozygous population. The odds are rather great that the genetic variances for populations Sel. A54-1 hi and 57-7991 CMS are larger than the genetic variance of A54-1.

As shown by the magnitude of the F values listed in the 5th column of table 3, the genetic variances of all populations other than 55-8035 are significantly greater than 0. From a study of the genetic variances and the obtained variances, one might conclude that population A58-1 offered the greatest potential for obtaining varieties having the highest percentage sucrose. However, the study of the means listed in table 2 indicates that such may not be the case. Frequency distributions should be helpful in evaluating the breeding potential of the different populations.

Variances for weight per root

The residual variances of weight per root given in table 4 can be attributed largely to genetic differences between plants. The genetic variance for Sel. A54-1 synthetic is not materially different from that for A54-1, the population from which it was derived. Also the genetic variances for

The genetic variances for Sel. 1541 synthetic and Sel. A54-1 in are less than the genetic variance for A54-1, the population from which they were derived. The odds are rather great that these differences are not due to chance. These populations were found to average significantly higher in percentage sucrose than A54-1. Apparently the genetic variability of these populations has been reduced compared with the population from which they were derived. Also, the genetic variability of the F_1 hybrid and inbred 55-8035 is significantly lower than that of A54-1. Undoubtedly this is due to the fact that the F_1 hybrid resulted from crossing two inbreds (52-430 X 52-414) and that comparatively 55-8035 is a relatively homozygous population. The odds are rather great that the genetic variances for populations Sel. A54-1 NT and 57-7591 (MS) are larger than the genetic variance of A54-1.

As shown by the magnitude of the F values listed in the 5th column of table 3, the genetic variances of all populations other than 55-8035 are significantly greater than 0. From a study of the genetic variances and the obtained means, one might conclude that population A56-1 offered the greatest potential for obtaining varieties having the highest percentage sucrose. However, the study of the means listed in table 2 indicates that such may not be the case. Frequency distributions should be helpful in evaluating the breeding potential of the different populations.

Variances for weight per root

residual ... ces of ... ght per root given in tabl... it can be ... to ge... differences between plants. The genetic variance ... is not materially different

Table 4. Obtained, estimated, environmental, and residual within plot variances, t values, and estimated and obtained standard errors for populations; the character being weight per root.

Population	Variances			t values 2/		Estimated standard error	Obtained standard error
	Obtained	Esti-mated 1/	Residual	A54-1 3/	55-8035		
A54-1	4.3141	0.9484	3.3657		6.722	0.9739	2.0770
Sel. A54-1 synthetic	4.3714	0.9995	3.3719	0.012	6.734	0.9997	2.0908
Sel. A54-1 hi	5.7022	0.9963	4.7059	2.677	9.399	0.9981	2.3879
Sel. A54-1 lo	4.0760	0.9197	3.1563	0.418-	6.304	0.9590	2.0189
57-7991 CMS	4.4808	1.1334	3.3474	0.037-	6.685	1.0646	2.1168
F_1 hybrid	2.4822	0.7634	1.7188	3.289-	3.433	0.8737	1.5755
55-8035 inbred	0.4699			6.722-			0.6855
A58-1	2.1573	0.7092	1.4481	3.830-	2.892	0.8421	1.4688

1/ Estimated from m and b calculated from population 55-8035, based on 80 replications; m equals 0.318990 and b equals -0.050024.

2/ The degrees of freedom for "t" is 474, and the t value for the 1 percent point is 2.588 and for the 5 percent point is 1.966; the standard error of a difference between residual variances is 0.5007.

3/ The minus sign after the t value indicates that the residual variance is less than the residual variance of A54-1.

Sel. A54-1 lo and 57-7991 CMS are not materially different from the genetic variance for A54-1. Sel. A54-1 hi is the only population that has a genetic variance that is significantly greater than A54-1, the population from which it was derived. The F_1 hybrid and A58-1 have environmental variances less than A54-1. All of the genetic variances are significantly different from zero as shown by the comparisons between them and 55-8035. The obtained variance of 55-8035 is used as an estimate of the environmental variance for a mean weight per root of 1.63 pounds. Regression is used to estimate the environmental variances of the other populations.

Frequency Distributions

A study of the genetic variances indicates that information of genetic and plant breeding interest can be obtained by partitioning the frequency distributions (Powers et al 1958).

Percentage sucrose

In table 5 are listed the obtained frequency distributions. Also in table 5 are shown the obtained frequency distributions partitioned into the number and proportion of genetic deviates in the lower and higher classes. Since the standard error for 55-8035 is used together with the means of the respective populations and together with tables of the normal probability integral to calculate the frequency distributions based on environmental variability only, it seems desirable first to examine the obtained frequency distribution of 55-8035 for normalcy.

Table 5. The obtained frequency distribution for percentage sucrose partitioned into the number and proportion of genetic deviates in the lower and higher classes.

Population and distribution	Upper limit of class, percentage																	Total in classes	
	8.25	9.00	9.75	10.50	11.25	12.00	12.75	13.50	14.25	15.00	15.75	16.50	17.25	18.00	18.75	19.50	20.25 and over	Lower	Higher
	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.
A54-1																			
Obtained							4	6	18	35	60	85	51	40	14	5	2	28	61
Calculated								3	11	36	69	88	68	33	10	2		14	45
Difference							4	3	7	- 1	- 9	- 3	-17	7	4	3	2	14	16
Proportion							1.00	0.50	0.39					0.18	0.29	0.60	1.00	0.50	0.26
Sel. A54-1 syn.																			
Obtained								2	4	17	33	81	63	79	28	5	8	23	120
Calculated									3	13	39	74	87	63	30	9	2	16	104
Difference								2	1	4	- 6	7	-24	16	- 2	- 4	6	7	16
Proportion								1.00	0.25	0.24				0.20			0.75	0.30	0.13
Sel. A54-1 hi																			
Obtained							2	9	10	44	53	73	65	39	15	7	3	65	64
Calculated								2	9	32	65	88	72	37	12	3		43	52
Difference							2	7	1	12	-12	-15	- 7	2	3	4	3	22	12
Proportion							1.00	0.78	0.10	0.27				0.05	0.20	0.57	1.00	0.34	0.19
Sel. A54-1 lo																			
Obtained								2	6	24	48	90	74	47	18	10	1	32	76
Calculated								1	5	19	50	80	84	54	21	5	1	25	81
Difference								1	1	5	- 2	10	-10	- 7	- 3	5	0	7	- 5
Proportion								0.50	0.17	0.21						0.50		0.22	
57-7991 CMS																			
Obtained			1		1	5	7	21	34	64	69	51	45	13	7	2		35	67
Calculated							2	12	37	71	87	67	32	10	2			14	44
Difference			1		1	5	5	9	- 3	- 7	-18	-16	13	3	5	2		21	23
Proportion			1.00		1.00	1.00	0.71	0.43					0.29	0.23	0.71	1.00		0.60	0.34
F_1 hybrid																			
Obtained				1		3	7	11	38	65	101	55	31	5	3				
Calculated							3	14	40	75	86	63	29	8	2				
Difference				1		3	4	- 3	- 2	-10	15	- 8	2	- 3	1				
55-8035 inbred																			
Obtained				1	5	23	56	103	88	33	8	2	1					85	44
Calculated				1	7	26	59	86	78	43	16	3	1					93	63
Difference					-2	- 3	- 3	17	10	-10	- 8	- 1						- 8	-19
A58-1																			
Obtained	2	1	3	5	11	22	46	55	54	57	32	20	8	3	1			90	64
Calculated					3	15	42	75	87	61	27	8	2					60	37
Difference	2	1	3	5	8	7	4	-20	-33	- 4	5	12	6	3	1			30	27
Proportion	1.00	1.00	1.00	1.00	0.73	0.32	0.09				0.16	0.60	0.75	1.00	1.00			0.33	0.42

The goodness of fit chi square for testing normalcy of the obtained frequency distribution has a value of 11.906 and p is less than 0.05. The odds are rather great against the deviations from normality being due to chance. A comparison of the obtained and calculated frequency distributions shows that there are more individuals than expected in the middle classes and fewer than expected in the lower and higher classes. It is desirable to know whether this same tendency is evident in other populations. An examination of the obtained and calculated frequency distributions provides information on this point. It has been shown from a study of the variances listed in table 3 that the genetic variances for percentage sucrose of populations Sel. A54-1 synthetic, Sel. A54-1 lo, and F_1 hybrid are low as compared with the genetic variance of A54-1. A study of the obtained and calculated frequency distributions for these populations shows that the modal class for all three has more individuals in the obtained frequency distribution than in the calculated frequency distribution. Hence the evidence is rather convincing that the environmental variability is such that the portion of the frequency distribution attributable to environmental variation is not strictly normal. This raises the question as to interpretation of the results if the environmental standard error of 55-8035 together with the mean of the respective population is used to calculate a frequency distribution and in turn this frequency distribution is used to partition the obtained frequency distribution. It can be seen that such a procedure would underestimate the number of genetic deviates in the lower and higher classes. Hence it would be a conservative estimate. If this is kept in mind while interpreting the data, partitioning the obtained frequency distribution provides additional information concerning these populations. The results are listed in table 5.

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shows that there are more individuals than expected in the middle classes

and fewer than ected in the lower and higher classes. It is desirable to

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nation of the obtained and calculated frequency distributions provides informa-

tion on this point. It has been shown from a stud of the variances listed

in table 3 that the genetic variances for percentage success of populations

Sel. A542 synthetic, Sel. A542 le and F_1 hybrid are low as compared with

the genetic variance of A542. A study of the obtained and calculated

frequency distributions for these populations shows that the modal class for

all has more individuals the obtained frequency distributions than

in the calculated frequency distribution. Hence the evidence is rather con-

ncing that the environmental variability such that the portion of the

frequency distribution attributable to environmental variability is not strictly

normal. This raises the question as to interpretation of the results if the

environmental standard error of 55-8035 together with the mean of the respec-

is used to calculate a frequency distribution and in turn

uency distribution is used to partition the obtained frequency

It is seen that such a procedure would underestimate the

e deviates in the lower and higher classes. Hence it would

estimates this a large and le partitioning the

frequency distribution provides additional

As previously pointed out, the means for percentage sucrose for Sel. A54-1 synthetic and Sel. A54-1 lo are significantly higher than the mean for percentage sucrose for A54-1 from which they were derived. As might be expected, both have frequency distributions shifted farther to the right than does A54-1. The mean percentage sucrose for Sel. A54-1 synthetic is 16.76 percent and for Sel A54-1 lo is 16.54. The difference of 0.22 percent is not statistically significant. The question arises as to which of these two populations offers the greater opportunity for further improvement by breeding. The primary interest is in those classes having the greatest number of genetic deviates for higher percentage sucrose. The partition of the obtained frequency distribution shows that these are the last 4 classes of table 5 for A54-1 and the populations derived from it. The number of individuals falling into this class for Sel. A54-1 synthetic is 120 and for Sel. A54-1 lo is 76. Homogeneity chi square calculated for these two populations is 14.238. The odds are greater than 99:1 against 120 and 76 being chance deviations from each other. As partitioned and shown in table 5, the genetic deviates in the higher 4 classes are 16 for A54-1 synthetic and -5 for Sel. A54-1 lo. It seems that further advances can be made in Sel. A54-1 synthetic. Such may not be the case for Sel. A54-1 lo.

The question arises as to what magnitude of increase might be expected. There is a second mode in the frequency distribution of Sel. A54-1 synthetic that has an upper class limit of 18.00. The class center is 17.625 percent. If this is a true second mode and if breeding procedures are available or could be developed that would concentrate the desirable genes in the population so that all individuals would be of those genotypes fluctuating about

this mode, further breeding should result in an increase of another 0.86 percent. This may and probably would necessitate growing some type of hybrid.

Partitioning out of the genetic deviates shows that it should be possible to make decided improvement in populations Sel. A54-1 hi, 57-7991 CMS, and A58-1. It is interesting to consider population A58-1. The estimated number of genetic deviates as shown by the differences for the higher classes of the frequency distribution indicates that there is a group of plants of such genetic constitution that they are segregating around a mean in the class having an upper class limit of 16.50 percent. The class center is 16.125. This is very close to 16.10 the mean percentage sucrose for A54-1. Therefore, it seems the percentage sucrose of A58-1 can be raised to the level of that of A54-1.

The findings are in accord with those reached from studying the genetic variances. It will be recalled that all the populations other than 55-8035 had genetic variances significantly greater than 0.

Weight per root

The obtained frequency distributions for weight per root partitioned into the number and proportion of genetic deviates in the lower and higher classes are listed in table 6. The purpose of the breeding program as practiced so far was to increase the proportion of the genetically superior individuals in the population as compared with A54-1. If such has been done this will be reflected in both the means and the frequency distributions. It has already been shown that, taking all the data for all the years, there has been an increase in weight of root over A54-1 for Sel. A54-1 synthetic, Sel.

breeding should result in an increase of [illegible]

records. This may [illegible] probably would necessitate [illegible] some type of

hybrid.

Partitioning out of the genetic deviates shows that it would be [illegible] to make distinct improvement in populations [illegible] 57-7901 [illegible] 1957-1. It is interesting to contrast population 1958-1. The estimated no. of genetic deviates as shown by the differences for the higher mean frequency distribution indicates that there is a group of [illegible] of ewes [illegible] consistently [illegible] around a mean [illegible] upper class limit of 12.56 percent. The [illegible] This is very [illegible] 10.40 [illegible] percent [illegible] for 1-1. [illegible] of 1958-1 [illegible] helped [illegible] level of 125-1.

The findings are in accord with those reached from studying the g[illegible] variances. It will be recalled that all the populations other than [illegible] had genetic variances significantly greater than 0.

Fat per cent

The number and proportion of genetic deviates [illegible] are listed in table 6. The purpose of the breeding program so far was to increase the proportion of the genetically superior [illegible] in the population as compared with 1950-1. [illegible] both the means and the frequency distributions. [illegible] that, taking all the data for all the years, there is

Table 6. The obtained frequency distributions for weight per root partitioned into the number and proportion of genetic deviates in the lower and higher classes.

Population and distribution	Upper limit of class, pounds: 0 to 0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0 and over	Total in classes: Lower	Higher
	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.
A54-1																
Obtained	15	17	25	38	33	39	32	30	27	17	10	9	11	17	95	64
Calculated		4	11	24	43	61	64	53	34	17	6	2	1	0	39	26
Difference	15	13	14	14						0	4	7	10	17	56	38
Proportion	1.00	0.76	0.56	0.37							0.40	0.78	0.91	1.00	0.59	0.59
Sel. A54-1 synthetic																
Obtained	14	17	24	35	17	37	45	31	19	27	14	11	10	19	90	81
Calculated	1	3	8	20	37	55	63	57	40	22	10	3	1	0	32	36
Difference	13	14	16	15						5	4	8	9	19	58	45
Proportion	0.93	0.82	0.67	0.43						0.19	0.29	0.73	0.90	1.00	0.64	0.56
Sel. A54-1 hi																
Obtained	18	14	28	32	40	37	24	21	19	24	18	9	12	24	132	87
Calculated	1	2	9	20	38	55	63	56	40	22	10	3	1	0	70	36
Difference	17	12	19	12	2					2	8	6	11	24	62	51
Proportion	0.94	0.86	0.68	0.38	0.05					0.08	0.44	0.67	0.92	1.00	0.47	0.59
Sel. A54-1 lo																
Obtained	15	21	32	32	46	34	25	23	22	22	21	8	5	14	100	70
Calculated	1	4	12	28	47	63	64	50	31	14	5	1	0	0	45	20
Difference	14	17	20	4						8	16	7	5	14	55	50
Proportion	0.93	0.81	0.62	0.12						0.36	0.76	0.88	1.00	1.00	0.55	0.71
57-7991 CMS																
Obtained	5	7	15	36	32	35	30	29	33	21	23	17	12	25	95	77
Calculated	0	2	5	11	23	40	54	59	53	37	21	10	4	1	41	36
Difference	5	5	10	25	9						2	7	8	24	54	41
Proportion	1.00	0.71	0.67	0.69	0.28						0.09	0.41	0.67	0.96	0.57	0.53
F_1 hybrid																
Obtained	12	25	41	47	55	35	26	25	20	18	10	3	1	2	78	54
Calculated	3	9	25	48	68	71	52	29	11	3	1	0	0	0	37	15
Difference	9	16	16						9	15	9	3	1	2	41	39
Proportion	0.75	0.64	0.39						0.45	0.83	0.90	1.00	1.00	1.00	0.53	0.72
55-8035 inbred																
Obtained	4	42	96	93	58	22	5									
Calculated	16	41	79	90	62	25	6	1								
Difference	-12	1	17	3	-4	-3	-1	-1								
A58-1																
Obtained	13	21	50	61	43	45	29	28	6	11	7	3	2	1	145	58
Calculated	4	12	31	57	74	68	44	21	7	2	0	0	0	0	104	30
Difference	9	9	19	4				7	-1	9	7	3	2	1	41	28
Proportion	0.69	0.43	0.38	0.07				0.25		0.82	1.00	1.00	1.00	1.00	0.28	0.48

A54-1 hi, and 57-7991 CMS. The first two of these populations were derived from A54-1, and 57-7991 CMS had populations Sel. A54-1 hi and Sel. A54-1 lo as the male parent. It is interesting to consider whether Sel. A54-1 synthetic and Sel. A54-1 hi have more individuals in the higher classes of the frequency distribution than A54-1.

Both Sel. A54-1 synthetic and Sel. A54-1 hi have more individuals in the higher classes of their frequency distributions than does A54-1 in its frequency distribution. However, calculation of homogeneity chi square shows that the odds are less than 19:1 against these differences being due to chance. Also, these two populations have a greater number of genetic deviates falling into the higher classes, but again calculation of homogeneity chi square shows that the odds against these differences being due to chance are less than 19:1. The frequency distributions of A54-1 and Sel. A54-1 lo are not materially different. Population 57-7991 CMS has fewer individuals in the lower classes of the frequency distribution and more in the higher classes, whereas the reverse is true for the F_1 hybrid, 55-8035, and A58-1. The proportions of genetic deviates in the higher classes are not materially different, with the exception of 55-8035. Population 55-8035 does not show any genetic deviates. This follows since it was employed in estimating the environmental variances.

Further study of the frequency distributions of table 6 discloses that for populations Sel. A54-1 synthetic, Sel. A54-1 hi, and A58-1 modes occur in the 5.0 pounds class. A mode occurs in the 5.5 pounds class for population 57-7991 CMS. One interpretation of these modes is that genotypes in the first three mentioned populations are segregating around a mean of 5.0 pounds and for populations 57-7991 CMS around a mean of 5.5 pounds. Since all of these

populations show these modes, it seems justified to conclude that they are significant. The breeding problem presented by these modes is how to obtain populations entirely composed of the genotypes represented by the plants responsible for these modes. The mode of 5.0 pounds represents a class center of 4.75 and an increase over the mean (3.13) of A54-1 of 152 percent; whereas the class center of the 5.5 pounds mode is 5.25 and represents an increase of 168 percent above the mean of A54-1.

To accomplish such an objective, new breeding techniques and methods may have to be developed. Their development could well be dependent upon information obtained from genetic studies of such genotypes. In turn, the genetic studies are dependent upon the isolation of these genotypes. Also, such derived fundamental information would greatly expedite the selection of the most efficient breeding methods known and facilitate their application. Further, genetic studies involving these genetically superior individuals should provide fundamental information on heterosis and homeostasis.

Joint Frequency Distribution for Percentage Sucrose and Weight per Root

The obtained and calculated number of roots having less than 16.50 percent sucrose and weighing less than 4.5 pounds compared with the number of roots having more than 16.50 percent sucrose and weighing more than 4.5 pounds are listed in table 7. Sel. A54-1 synthetic has a greater number of individuals having more than 16.50 percent sucrose and weighing more than 4.5 pounds than does A54-1, the population from which it was derived. The odds against the difference noted being due to chance is greater than 99:1. The other two populations derived from A54-1 do not differ materially from

[illegible] is [illegible] to [illegible]

[illegible] percentage [illegible]

[illegible] represented [illegible]

[illegible] 0.5 [illegible] percentage [illegible]

[illegible] (5.13) [illegible] 12-5 [illegible] 29 [illegible]

the 9.5 pounds mode is 9.2% and represents an increase

[illegible], not [illegible] and [illegible]

their development [illegible]

[illegible] such phenotypes. [illegible]

[illegible] of these phenotypes.

[illegible] greatly [illegible]

known [illegible] their significance

[illegible] practically [illegible]

[illegible]

[illegible] and weight [illegible]

[illegible] less than 10.5 [illegible]

giving less than 8.5 pounds compared with the number of

[illegible] percent [illegible] and weighing more than 5.

[illegible] a greater [illegible]

[illegible] percent [illegible] weighing [illegible]

[illegible] population [illegible] derived.

[illegible] being due to chance is greater than 9

[illegible]

Table 7. Obtained and calculated number of roots having less than 16.50 percent sucrose and weighing less than 4.5 pounds compared with the number of roots having more than 16.50 percent sucrose and weighing more than 4.5 pounds.

Population	Less than 16.50 percent and 4.5 pounds		More than 16.50 percent and 4.5 pounds	
	Obtained	Calculated 2/	Obtained	Calculated 2/
	No.	No.	No.	No.
A54-1 1/	309	304	11	16
Sel. A54-1 synthetic 1/	290	274	30	46
Sel. A54-1 hi	303	285	17	35
Sel. A54-1 lo	309	288	11	32
57-7991 CMS	306	301	14	19
F_1 hybrid	318	314	2	6
55-8035	320	320	0	0
A58-1	320	320	0	0

1/ The homogeneity chi square computed from the obtained frequency distributions of A54-1 and Sel. A54-1 synthetic is 9.408 with one degree of freedom. The odds are greater than 99:1 against the differences noted being due to chance.

2/ The calculated frequency distributions are computed by assuming that percentage sucrose and weight per root are independent.

it in this respect. The same is true of 57-7991 CMS. It should be easier to obtain high sucrose and high yield in population Sel. A54-1 synthetic than in the other populations. Apparently the attempt to increase the number of genotypes in this population conducive to both high sucrose and high yield has been successful.

The obtained frequency distributions compared with the calculated frequency distributions show that percentage sucrose and weight per root are not independent. For every population there are more expected than obtained. The relation is negative. It seems desirable to determine the proportion and number of genetic deviates in classes for which the proportion of genetic deviates can be estimated.

In table 8 is given the frequency distribution for percentage sucrose and weight per root for Sel. A54-1 synthetic. The solid line demarks those individuals having more than 16.50 percent sucrose and which weigh more than 4.5 pounds. The totals are shown in column 4 of table 7.

The dotted line, together with the solid lines below and to either side, demarks those individuals among which would be expected some genetic deviates superior for both characters. It is desirable to have an estimate of the proportion and number of genetic deviates superior for both characters in those classes for which the proportions of genetic deviates can be estimated.

Table 8. Frequency distribution for percentage sucrose and weight per root, Sel. A54-1 synthetic.

Percent sucrose	Weight per root, pounds														Total
	0 to 0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0 and over	
%	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.
13.50						1			1						2
14.25						1						1	2		4
15.00				1		1	2	1		1	3	3		5	17
15.75			1	1	4	2	7	1	2	3	1	1	4	6	33
16.50	4	4	6	6	2	9	8	11	10	10	1	1	3	6	81
17.25	2	1	4	10	2	8	12	6	2	7	2	5		2	63
18.00	3	10	4	10	5	12	11	9	3	6	5		1		79
18.75	3	1	6	4	3	2	4	2	1		2				28
19.50	1			2			1	1							5
20.25 & over	1	1	3	1	1	1									8 0.572
Total	14	17	24	35	17	37	45	31	19	27	14	11	10	19 0.253	320

Obtained = 30
Calculated = 46

Genetic Deviates Superior for Both Characters in Those Classes for Which the Proportions of Genetic Deviates Can Be Estimated

Estimates of the proportion of individuals genetically superior for both characters in classes for which the proportions of genetic deviates can be estimated are listed in table 9.

In making the estimates it was determined which classes have some identifiable proportions of genetic deviates. It can be seen by an examination of tables 5 and 6 that for Sel. A54-1 synthetic all classes containing individuals having more than 17.25 percent sucrose and individuals whose roots weigh more than 4.5 pounds fall in this category. In table 8 is shown the bivariate frequency distribution for percentage sucrose and weight per root. The dotted line and the solid lines demark those individuals falling in classes having more than 17.25 percent sucrose and whose roots weigh more than 4.5 pounds.

The greatest number (14) of individuals having more than 17.25 percent sucrose and weighing more than 4.5 pounds is found in Sel. A54-1 synthetic as shown by column 4 of table 9. The odds against this value of 14 and the value of 4 for A54-1 being chance deviations from a common frequency distribution is greater than 49:1. That is, the frequency distribution of 316:4 and 306:14 would be expected to occur as chance deviations from 309:11 less than 1 time in 50. The estimated proportion of genetic deviates among these 4 and 14 individuals are listed in column 5 of table 9. Some idea as to whether these estimated proportions of genetic deviates are significantly different can be determined by homogeneity chi square applied to the frequencies of genetic deviates among the individuals falling in the classes under consideration. For example, for A54-1, 0.26 or 16 individuals among a total of 61 are estimated as genetic deviates. The corresponding values for Sel. A54-1 synthetic are 0.13 or 14 individuals among 120. The homogeneity chi square for testing whether 61:16 is significantly different from 120:16 has a value of 3.082. The odds are somewhat less than 19:1 against these differences being due to chance. It is obvious without application of the homogeneity chi square test that proportions of 0.59 for A54-1 and 0.56 for Sel. A54-1 synthetic do not differ materially. Hence it would seem that the proportions of genetic deviates 0.0019 and 0.0032 listed in the 5th column of table 9 represent significant differences. At least the odds are in favor of A54-1 synthetic and other considerations being equal the plant breeder would select population A54-1 synthetic as having the greatest potential for increasing both percentage sucrose and weight per root.

Table 9. Number and proportion of genetic deviates superior for both characters in classes having identifiable proportions of genetic deviates.

Population	Root over 1/ Sucrose	Root over 1/ Weight	Obtained number in 320	Estimated proportion of genetic deviates
	%	Lbs.		
A54-1	17.25	4.5	4*	0.0019
Sel. A54-1 synthetic	17.25	4.5	14*	0.0032
Sel. A54-1 hi	17.25	4.5	6	0.0021
57-7991 CMS	16.50	5.0	9	0.0051
A58-1	15.00	3.5	10	0.0063

1/ The individuals listed in column 4 exceed the corresponding values for percentage sucrose and weight per root listed in columns 2 and 3.

* Homogeneity chi square is 5.7190 and the odds against these being chance deviations are greater than 49:1.

Curly-Top

The numbers of plants not showing visible curly-top symptoms and the numbers and percentages of plants showing curly-top symptoms among 960 plants examined are shown in table 10. Sel. A54-1 synthetic and Sel. A54-1 hi are both significantly lower in the percentage of plants showing curly-top symptoms than is A54-1. Sel. A54-1 lo is not significantly different from A54-1 in this respect.

These data are presented because of the possible bearing they may have upon the interpretation of the weight per root data given in previous tables. In 1957 in a polycross test, the material from which Sel. A54-1 synthetic was derived yielded 7.1 percent more than A54-1. Curly-top in 1957 was not a factor. In the 1958 studies the increase in weight per root was 5.1 percent and curly-top could have been a factor. In the population genetic studies in which the rows were double spaced Sel. A54-1 hi showed an increase of 4.8 percent over A54-1 in weight per root; whereas, in a polycross test grown the same year and in which the spacing between rows was standard rather than double, as in the population genetic studies, the increase in yield of roots was 6.1 percent. In this latter test the frequency of visible curly-top plants did not warrant making percentage determinations.

In harvesting the population genetic studies, only plants free from visible symptoms of curly-top were taken. However, this alone does not insure that the organism causing curly-top could not have been playing some part in regulating yield of roots as late infection and latent infection might have been involved.

The above facts are presented so that the reader can make his own evaluation of the findings from the population genetic studies at one level of soil fertility.

Table 10. Number of plants not showing visible curly-top symptoms and number and percentage of plants showing curly-top symptoms among 960 plants examined.

Population	Curly-top		Percent showing symptoms
	No symptoms	Symptoms	
	No.	No.	%
A54-1 2/	812	148	15.42
Sel. A54-1 synthetic	864	96	10.00
Sel. A54-1 hi 2/	843	117	12.19
Sel. A54-1 lo	810	150	15.62
57-7991 CMS	951	9	0.94
F_1 hybrid	896	64	6.67
55-8035	960	0	0.00
A58-1	950	10	1.04

1/ Homogeneity chi square based on all 8 populations is 401.147, based on the first four populations is 18.318, and based on the last four populations is 125.841. In all cases the odds against the deviations noted being due to chance are greater than 99:1.

2/ The homogeneity chi square involving only A54-1 and Sel. A54-1 hi is 4.207 and the odds are greater than 19:1 against the deviations noted being due to chance.

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Weight per Root and Percentage Sucrose per Root for Beets Having the Following Phenotypes: Red, Red Hypocotyl, Green Hypocotyl, and Yellow

Originally, in this material the genes conditioning red beets, red hypocotyls, and yellow beets were derived from the red garden beet. The study was run on material segregating for cytoplasmic male sterility. The history of this material follows. In 1955 the cytoplasmic male-sterile SL 211 H 3 was exposed to pollen from 22 different sources. These 22 sources were composed of varieties, strains and inbreds. Among the inbreds was one having red beets and originally derived from sugar beet-garden beet crosses. Material grown from seed collected from SL 211 H 3 had some cytoplasmic male-sterile red beets. These were exposed to pollen of 40 beets selected from small units grown at a high fertility level and 40 beets selected from small units grown at a low fertility level. Beets grown from seed saved from these cytoplasmic male-sterile red beets were used in these studies on weight per root and percentage sucrose.

The number of roots analysed, weights per root, and percentages of sucrose are listed in table 11 for the following phenotypes: Red roots, red hypocotyls and white roots, green hypocotyls and white roots, and yellow hypocotyls and yellow roots. The difference between the green hypocotyl and white roots and the red roots in weight per root is 0.23 ± 0.0943. The t test gives a P value slightly less than 0.02. In this study the green hypocotyl beets having white roots are heavier than those beets having red roots. The increase in weight is 15 percent. The increased weight of the red hypocotyl beets having white roots over the red beets is 0.13 ± 0.0839 and the increased weight of the green hypocotyl beets having white roots over the red hypocotyl beets having white roots is 0.10 ± 0.1028. By the t test the odds against these

differences being chance deviations from zero are 7 to 1 and 5 to 1, respectively. The number of individuals in the yellow hypocotyl and yellow root class is so small that the mean is highly inaccurate. This is shown by the magnitude of the standard error.

For percentage sucrose the difference between the green hypocotyl beets having white roots and the red beets is 0.12 percent and the green hypocotyl beets having white roots and red hypocotyl beets having white roots is 0.19 percent. In neither case is it logical to conclude that these values are other than chance deviations from zero. Hence, these data fail to demonstrate any significant differences between the 4 phenotypes as regards percentage sucrose.

The genes differentiating the 4 phenotypes (red beets, red hypocotyls and white roots, green hypocotyls and white roots and yellow hypocotyls and yellow roots) in certain material should prove valuable as markers in studying the nature of the interaction of genes conditioning weight per root. Such studies should add to our knowledge of the fundamental genetic principles governing the phenomena of heterosis and homeostasis.

Before drawing definite conclusions, further studies are needed involving more material and more growing seasons. However, these data point out the desirability for sugar beet breeders to take note of such possible relations in their breeding material.

Table 11. The degrees of freedom, means, and standard errors for weight per root and percentage sucrose.

Phenotype	Number roots analysed	Weight	Sucrose
	No.	Lbs.	%
Red beets	305	1.53 ± 0.0518	13.91 ± 0.1038
Red hypocotyl	216	1.66 ± 0.0660	13.84 ± 0.1385
Green hypocotyl	157	1.76 ± 0.0788	14.03 ± 0.1639
Yellow beets	10	1.76 ± 0.3098	13.34 ± 0.5986

Relation of Polyploidy and Yield in Inbred Lines of Sugar Beets

During the last fifteen years, polyploid sugar beets have become of interest in many European countries. Breeders in these countries are using polyploids extensively under the assumption that polyploidy increases the productivity of sugar beets. Breeders in the United States have only recently commenced extensive breeding work designed to exploit possible benefits of polyploidy. This effort has been based partly on the apparent success of the Europeans and partly on the basis of the results of independent research in the United States.

The reason for increased yield of sugar beets in the polyploid condition has not been determined. The increases noted could be due to selection, heterosis, or true ploidy effect. In most polyploid breeding programs any yield increases are generally ascribed to the increased chromosome number without considering that possibly the same results may have been achieved through a similar breeding program at the diploid level.

The polyploid work at Fort Collins in 1959 was confined to the material listed in table 12. In table 12 are given the mean weights of root per plot and mean percentages sucrose in tetraploid and diploid inbred equivalents. The experimental design is a randomized complete block with three replications. The populations used are long-time inbred lines and are therefore assumed to be quite homozygous. Each of the tetraploid lines were in the C_4 generation and each originated from a single plant. Even though inbred lines were used, variability between ploidy levels may have been introduced due to mutagenic effects of the colchicine treatment. Since inbred lines were used, sampling variability should not be a problem even though only a few plants were treated to procure the tetraploids.

During the last few years, polyploid sugar beets have become ... countries.

... increase ... of sugar beets. Breeders ... have only ... exclusively ... This effort has been based ... on the ... increases and ... on the basis of ...

... reason for increased yield ... not been ... The increases noted could ... effects, ... yield effect. In most polyploid ... were generally ... found ... without concluding that exactly the same results ... or increasing progress at the diploid level.

... work at Fort Collins in 1950 was ... Table 12 are given ... a success in tetraploid ... inbred ... lines ... a randomized complete block ... the long-time inbred lines ... Each of the tetraploid lines ... than those ... have been ... only a ...

Table 12. Means for weight of roots per plot and percentage sucrose in tetraploid and diploid inbred equivalents; 1959 test.

Population	Generation	Weight per 10-root sample	Percent sucrose
52-430-1 (4n)	C_4	13.30	11.6
52-430 (2n)		10.57	12.5
52-430-2 (4n)	C_4	18.60	11.8
52-430 (2n)		9.27	11.9
52-430-4 (4n)	C_4	11.23	11.5
52-430 (2n)		9.73	12.1
52-307 (4n)	C_4	9.40	11.2
52-307 (2n)		10.57	10.7

The stand in all plots was good and the 10-root sample taken from each plot consisted of competitive beets. The top growth of all lines of 52-430 (4n) were not greatly different than their diploid counterparts; however, the top growth of 52-307 (4n) was greatly reduced in the early stages as compared to its diploid "equivalent". This differential gradually diminished until at harvest little difference could be detected in quantity of top growth. All tetraploid plants were examined for number of chloroplasts in the stomatal guard cells and no individuals of doubtful ploidy condition were detected.

It will be noted from table 12 that in all three lines of inbred 52-430 the weight of the 10-root sample is higher in the tetraploid than in its diploid "equivalent". However, for percent sucrose the opposite is true. This situation is reversed in the inbred 52-307. From table 13 it will be noted that neither populations nor ploidy levels are different for percent

sucrose, but for weight of root ploidy levels are significantly different as is shown by the magnitude of the first order interaction of ploidy levels with populations. In other words, not only are there differences between ploidy levels but also the different populations react differently when changed to a tetraploid condition. This results from the reversal in 52-307 of the yield pattern set by 52-430 and also by the wide yield differential between the tetraploid and diploid in 52-430-2.

Table 13. Analyses of variances for weight of roots per plot and percentage sucrose in tetraploid and diploid inbred equivalents; 1959 test.

Source of variation	Weight of root		Percent sucrose		F value at	
	Mean square	F value	Mean square	F value	5%	1%
Ploidy levels	57.6600	12.27*	0.4266		5.99	13.74
Populations	18.8300	4.01	1.4105	3.13	4.76	9.78
Replications	2.1454		2.2154	4.91	5.14	10.92
Reps. X levels	5.9662	1.27	0.3279		5.14	10.92
Reps. X Pops.	6.2321	1.33	1.1010	2.44	4.28	8.47
Levels X Pops.	29.8767	6.36*	0.5534	1.23	4.76	9.78
R X P X L	4.6996		0.4512			

The studies reported herein should be taken only as indicative. Expansion of these studies is planned to allow comparisons in the diploid, triploid and tetraploid condition. Further comparisons involving ploidy levels will be made in F_1 combinations by crossing diploids and tetraploids with a common heterozygous cytoplasmic male sterile. Through these studies

it is anticipated that fundamental information will be gained about the true effect of ploidy level on yield of root and percent sucrose. Also, the interrelation of yield of root and percentage sucrose at different ploidy levels will be studied. Such information should enable the breeder to capitalize directly on any real beneficial effects of polyploidy.

Gametocide Test on Sugar Beets

A field experiment to test the effectiveness of 2,3-dichloroisobutyrate (Rohm and Haas, FW-450) as a gametocide on sugar beets was conducted in 1959 at Fort Collins, Colorado. This was a continuation of experiments with FW-450 commenced in 1958 at Fort Collins by Dr. John W. Dudley.

The 1958 results were used to determine treatments for the experiment conducted in 1959. The 10 treatments used are listed in table 14. The design was a randomized complete block with 4 replications. The plant material consisted of 200 plants of 52-305, a self-fertile green hypocotyl inbred having white roots and 220 plants of A58-5, a heterogenous line homozygous for yellow hypocotyl and yellow root. Plants of 52-305 received the FW-450 treatments and hence seed collected from these plants was analysed for yield, percentage germination and percentage hybrids. Genes conditioning yellow hypocotyl and yellow roots are dominant to genes conditioning green hypocotyls and white roots. There were five plants in each treatment plot with all treatment plots being bordered on both sides by five pollen parent plants. The rows were spaced three feet and plants within rows were spaced three feet. This greatly facilitated movement of spraying equipment within the experimental area.

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[illegible] Test on Sugar Beets

A field experiment to test the effectiveness of 2,4-dich[illegible]

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Collins, Colorado. This was a continuation of

[illegible] in 1950 at Fort Collins [illegible] Dr. John O. Gaskill.

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[illegible] feet of plants [illegible] row

[illegible]

Table 14. Mean number of days from June 1 to first flower, number of days from first flower to pollen shedding, seed yield per plant in grams, and percentage germination for the treatments applied in the 1959 gametocide experiment.

Treatment number and treatment	Days from June 1 to 1st flower	Days from 1st flower to 1st pollen	Seed yield	Percentage germination
	Days	Days	Grams	%
(1) 0.50% EB[1], 0.33% 1st PMC[2], 0.25% later PMC	26.30	12.1*	48.75*	22.50*
(2) 0.33% EB, 0.33% 1st PMC, 0.33% later PMC	27.55	11.0*	52.78*	32.50*
(3) 0.25% EB, 0.25% 1st PMC, 0.25% later PMC	26.55	11.7*	57.78*	30.75*
(4) 0.50% EB, 0.33% 1st PMC	27.95	10.7*	58.38*	34.25*
(5) 0.33% 1st PMC, 0.33% later PMC	24.50	6.8*	76.63	45.50
(6) 0.33% 1st PMC, 0.25% later PMC	25.90	8.2*	73.15*	40.00
(7) 0.25% 1st PMC, 0.25% later PMC	25.65	5.6*	73.61*	40.25
(8) 0.33% 1st PMC	25.35	5.8*	82.62	52.75
(9) 0.25% 1st PMC	24.25	2.5	104.38	63.50
(10) Check, no treatment	25.00	1.2	102.30	51.75

* Odds are greater than 19:1 that these means are not chance deviations from the check.

1/ EB = early bolting stage.

2/ PMC = pollen mother cell stage.

All concentrations of the gametocide were applied in an aqueous solution at a carrier rate of 100 gallons per acre. This quantity wet to the run off point those plants treated in the early bolting stage. Plants treated in the first pollen mother cell stage and later pollen mother cell stage had all leaf surfaces wet near the run off point. No wetting agent was used. A shield was used in application, eliminating drift as a factor in the experiment. The dates of application for the three maturity stages were June 9, 16, and 20. The growth period from June 9 to June 27 was accompanied by unseasonably hot, dry weather which greatly hastened maturity.

The early bolting stage treatment was applied when the plants had 4-to 10-inch seed stalks. The first pollen mother cell stage treatment was made just prior to microsporogenesis in the earliest flowers. The later pollen mother cell stage treatment was applied when the microspores of the earliest flowers were in the late tetrad stage, a time at which a majority of the flowers were in microsporogenesis.

The means for the characters, number of days from June 1 to first flowering, number of days from first flowering to pollen shedding, seed yield per plant in grams, and percentage germination are shown in table 14. There was no significant delay in flowering date which is commensurate with observations since there was little leaf burning, curling, or phytotoxic effect accompanying any of the treatments. Only one plant failed to flower and it had curly-top symptoms.

The means for days from first flowering to pollen shedding are calculated, using only those plants which actually shed pollen. There were only 5 of the

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[illegible] first flowering to pollen shedding [illegible] calculated, [illegible] [illegible] [illegible] pollen. There were [illegible] of

200 treated plants which failed to shed pollen, but this was not a treatment effect. These plants were diseased. There were significant delays in pollen shedding in relation to the check plots, with the most severe treatment delaying dehiscence about 12 days. Pollen shedding in the check plots occurred, on the average, slightly more than one day after flowering. There was also a significant difference in days until dehiscence between those plots treated in the early bolting stage and those plots treated only in the first pollen mother cell and later pollen mother cell stages.

Pollen viability checks were made but were not an effective measure of the treatment effect. When natural dehiscence occurs, the pollen seems without exception to have a viability count similar to that of the untreated check. There was no viable pollen found in any non-dehiscent anthers.

Seed yields were significantly reduced in six of the nine treatments with those plots receiving the early bolting stage treatment being most severely effected. Seed yield was reduced about 50 percent in these plots as compared to the untreated check. In general there was a trend toward seed yield reduction with increasing concentration and earliness of treatment.

The percentage of the seedballs which produced at least one healthy sprout in 15 days in the germinator is shown in table 14. The only significant reduction in germination was shown by those plants which received early bolting stage treatments. However, the other treatments had a consistently lower germination percentage than the check excepting those plants receiving treatment only in the first pollen mother cell stage. In these latter two treatments the percentage germination was slightly higher than the check. However, these increases are probably not different from zero.

Genes w/ 8 failed to [illegible] pollen but this was not a [illegible]

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The results of hypocotyl color counts on seed from the different treatments are shown in table 15. Since the treated parent, 52-305, has green hypocotyls, any yellow hypocotyl progeny must have resulted from crosses with A58-5. Thus the percentage of yellow hypocotyl plants obtained from the treated parent is a measure of the effectiveness of the gametocide. From table 15 it can be seen that the percentage of yellow hypocotyl plants from the untreated check plots is only 7.9 percent. This indicates that 52-305 is quite highly self-fertile. There was no means of measuring the probability

Table 15. Number of yellow and green hypocotyl seedlings obtained from the treated plants, 52-305.

Treatment number	Plant hypocotyl color		Total	Yellow hypocotyl plants
	Yellow	Green		
	No.	No.	No.	%
1	109	186	295	36.9
2	103	224	327	31.5
3	113	263	376	30.1
4	92	270	362	25.4
5	131	317	448	29.2
6	116	233	349	33.2
7	97	294	391	24.8
8	128	341	469	27.3
9	101	397	498	20.3
10	38	444	482	7.9

of pollination by A58-5. However, each treatment plot was surrounded by plants of A58-5 which should have increased the likelihood of pollination by those plants over pollination by 52-305 from pollen produced in the untreated check plots and treated plants within each plot. A minimum of 50 percent yellow hypocotyl plants would be expected if 100 percent crossing had occurred, but

due to proximity and preponderance of A58-5 pollen available it is likely that the percentage hybrids as recorded in table 15 represent well over half of the actual amount of crossing which took place.

All treatments were significantly higher in percentage hybridization than the untreated check. From table 16 it can be seen by the chi square values that in considering all treatments differences do exist, but in comparing concentrations and stages of treatment the only observed difference was in concentration for those plants treated in the early pollen mother cell and later pollen mother cell stages. Thus, differences for treatment stages and for concentrations, except in the two pollen mother cell stage treatments, were not great enough to have a significant chi square. However, the over-all trend is toward greater hybridization with increasing concentration and number of applications.

Table 16. Chi square values in tests of homogeneity.

Treatments tested	Chi square	P value
All treatments	257.29	less than 0.005
1, 2, 3	3.83	0.20
5, 6, 7	6.40	less than 0.05
1,2,3 and 5,6,7	3.37	0.10
2 and 5	0.45	0.50
1 and 6	0.96	0.50
3 and 7	2.65	0.15

The results of this experiment indicate that there is no delay of flowering of treated plants but the production of pollen is delayed and the amount of hybridization is significantly increased. However, the most severe

treatment produced only 36.9 percent desirable hybrids. Therefore, the total crossing could not have exceeded 73.8 percent, assuming the yellow hypocotyl plants represented only half the crosses. Also, quite deleterious effects on seed yield and percent germination occur.

Considering that only partial hybridization was achieved and that seed yield and germination percentage was greatly reduced, it would seem that we do not yet have sufficient information and techniques to use FW-450 in a commercial hybrid program.

P A R T VIII

RHIZOCTONIA INVESTIGATIONS

Inoculation Techniques and Selecting for Resistance

Foundation Project 25

J. O. Gaskill

Research conducted in cooperation with the Botany and Plant Pathology Section, Colorado Agricultural Experiment Station.

RHIZOCTONIA RESISTANCE BREEDING INVESTIGATIONS FORT COLLINS, COLORADO, 1959 1/

(A phase of Beet Sugar Development Foundation project no. 25)

John O. Gaskill 2/

Rhizoctonia resistance breeding investigations during 1959 included further studies on inoculation techniques and the testing of progenies of roots previously selected for resistance. Field plots were located on the Hospital Farm near Fort Collins, Colorado.

Inoculation Methods

Post-Thinning Inoculation:

The experiment of most interest in 1959 (experiment R-1) involved 3 Rhizoctonia isolates, known to differ widely in pathogenicity to sugar beets; 12 sugar beet strains (see table 2) that were thought to differ somewhat in resistance to Rhizoctonia; and the following inoculation methods:

1. Inoculum applied in contact with the tap root, approximately 1" to 1 1/4" below the soil line (soil replaced to original depth after placement of inoculum).

2. Inoculum applied in a semicircle, approximately 3/4" from the tap root and 1" below soil line (soil replaced as above).

3. Inoculum applied in the center of the foliar rosette and permitted to fall on the surface of the soil below at will.

The experiment consisted of 2 replications, each of which contained 3 inoculation methods as main plots. Each of the latter included 3 sub-plots of isolates and 1 sub-plot, designated "A", which was not inoculated. Each sub-plot contained 12 sub-sub-plots representing the 12 respective sugar beet strains. A split-split-plot experimental design was employed, with maximum use of randomization. The entire experiment

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1/ Cooperative research conducted by the Crops Research Division, A.R.S., U.S.D.A., and the Botany and Plant Pathology Section, Colorado Agricultural Experiment Station, supported in part by funds contributed by the Beet Sugar Development Foundation.

2/ Plant Pathologist, Crops Research Division, A.R.S., U.S.D.A.

consisted of 288 sub-sub plots, each of which was 1 row x 20'. The crop was planted June 30 - July 1 and thinned (approximately 8" spacing) at about the usual stage of plant development. The inoculation job was performed August 5 - 6, approximately 1 week after thinning, using 1/6 teaspoon of dry, ground, barley grain inoculum per plant. The field was in a good state of fertility and adequate soil moisture was supplied by sprinkler. At harvest (October 9 - 12), the living plants in each sub-sub plot were counted, and the roots were trimmed as mother beets, washed, and weighed.

Results of this experiment are summarized in tables 1 and 2 and illustrated in figures 1, 2, 3, and 4. The most striking feature of table 1 is the severe killing caused by isolate D. The percentages given for that isolate reflect the survival of only 3 plants in 72 sub-sub plots which had contained a total of more than 1500 plants at time of inoculation. Isolate B caused negligible loss of stand, and C was intermediate, resulting in an average loss of 22 percent.

Isolate C offers the only opportunity to compare strains and methods. Since many surviving plants were badly stunted where isolate C had been used, a study of root yields permits a more critical appraisal of method and strain effects, than is afforded by stand counts. Since isolate B caused no observable effect on the plants, yields for the corresponding sub-sub plots of A and B, within methods, were averaged to provide bases for expression of the yields of the sub-sub plots of isolate C as percentage of check. The yield data for isolate C, expressed in that manner, are summarized in table 2. As shown by the F-test, the interaction, methods x strains, was negligible. Differences among strains approached but did not reach the 5-percent level of significance. The average yield for the 5 strains representing known selection for Rhizoctonia resistance was 65.69 percent of check, 6.64 higher than the average for the other 7 strains. This difference rather closely approached the 5-percent level of significance. Inoculation methods differed significantly in their effect on yield.

Since regulation of intensity of exposure to Rhizoctonia is of prime importance in connection with selection and testing for resistance, the differences among inoculation methods, in severity of disease attack (table 2), are of special interest. There were very few apparent escapes in the plots of any of the 3 methods, where isolate C was used, and none in the plots of isolate D. It is recognized that, under certain conditions, the percentage of escapes probably would be substantially greater for method 3 than for either of the other 2 methods. Ordinarily the lowest percentage of escapes could be expected in method 1. However, a possible disadvantage in the use of that method is the placement of inoculum in contact with the tap root at a point where numerous feeder roots have just been broken mechanically. Such an inoculation technique places the plant at a serious disadvantage. It is conceivable that dependence upon such a technique for selection and testing purposes could eliminate the

possibility of finding and utilizing certain types of resistance or tolerance to Rhizoctonia. Because of these considerations, method 2 — with modifications in placement, timing, etc. — appears to be more promising than either of the other two methods, insofar as the immediate future is concerned. Further study of this question is needed.

Inoculation at Time of Planting:

Experiment R-2 was conducted for the purpose of studying the usefulness of inoculum application with the seed as a means of comparing sugar beet strains for Rhizoctonia resistance. The Rhizoctonia isolates and sugar beet strains used in experiment R-1 were employed in R-2. A split-plot experimental design was used, with a total of 2 complete replications and 96 sub-plots (of strains), each sub-plot consisting of 1 row 12' long. Uniform rates of seeding and inoculum application were employed. The number of surviving plants in each inoculated sub-plot, approximately 3 months after planting, was expressed as percentage of the corresponding non-inoculated check plot.

Disease losses were severe in the inoculated plots which, as a whole, averaged 19.7 percent of check in final stand. According to the F-test, differences among sugar beet strains fell far short of that required for significance at the 5-percent level. The means for the 12 strains, obtained in experiment R-2, were compared with the corresponding root-yield means for isolate C, as given in table 2 (experiment R-1). The correlation coefficient ($r = 0.52$) was not significant.

Progeny Test

Forty strains of sugar beets, including 22 progenies of root selections made locally, for Rhizoctonia resistance, and 3 such progenies furnished by the Great Western Sugar Company (B-525, -579, and -590), were tested for Rhizoctonia resistance by means of a post-thinning inoculation method (experiment R-3). Individual plots were 1 row x 16' and each of the 40 strains occurred in 6 plots — 2 checks, 2 inoculated approximately 1 week after thinning, and 2 inoculated about 3 weeks after thinning. Planting, thinning, and general care of the crop were handled in a manner similar to that of experiment R-1. Dried, ground barley grain inoculum was used, consisting of a mixture of 6 Rhizoctonia isolates, 5 of which were known to be highly pathogenic to sugar beets and 1 of which was classed as medium in pathogenicity. The inoculation method designated as no. 1, for experiment R-1, was used. Plants considered as escapes, in inoculated plots, were quite rare and consisted largely of late-emerging individuals which were not inoculated. Plants in the check (non-inoculated) plots, in general, grew vigorously and remained healthy until harvest.

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[illegible]

Experiment 4-2 was conducted with the purpose of studying the [illegible] of [illegible] application, with [illegible] seed as a means of [illegible] [illegible] The Rhizoctonia [illegible] [illegible] used in experiment 2-1 were applied in 4-2. A [illegible] experimental design was used, with [illegible] of 3 complete replications and 9 sub-[illegible] of [illegible], each sub-plot consisting of [illegible] [illegible] as of seeding and [illegible] [illegible] of [illegible] [illegible] sub-plot, [illegible] other plants [illegible] was expressed as percentage of the [illegible] check plot.

[illegible] in the inoculated plots which [illegible] [illegible] [illegible] according to this [illegible] [illegible] [illegible] [illegible] for [illegible] of [illegible] [illegible] at the [illegible] level. The means for [illegible] [illegible] in experiment 4-2, [illegible] compared with the corresponding means for [illegible] are given in table [illegible]. The [illegible] coefficient [illegible] was not significant.

[illegible]

[illegible] including [illegible] of [illegible] [illegible] and [illegible] [illegible] were tested by means of a [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] until harvest.

Exclusive of probable escapes and plants classed as "nearly dead", there was only 1 surviving plant, at harvest, in the 80 plots inoculated early. In the 80 plots inoculated 2 weeks later, the corresponding number surviving at harvest was 30 (i.e. 2.0% of the inoculated population). Many of these were severely diseased, and only 9 (0.6% of the inoculated population) were considered worth taking as mother beets. The distribution of surviving plants and those selected as mother beets was such that no individual strain could be classed as more resistant or tolerant than the average.

The disease exposure in this test obviously was too severe for satisfactory Rhizoctonia resistance comparisons among strains. The effectiveness of selection under these conditions will be studied by means of subsequent progeny tests.

Table 1. Effect of Rhizoctonia isolate and inoculation method on survival of sugar beet strains at harvest; basic data given as 2-plot averages.

Strain	Rhizoctonia isolate, inoculation method, and percentage surviving plants at harvest															
	A a/				B a/				C a/				D a/			
	1	2	3	Aver	1	2	3	Aver	1	2	3	Aver	1	2	3	Aver
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
1	100.0	100.0	100.0	100.00	97.9	100.0	95.0	97.62	55.6	92.5	88.5	78.85	0.0	0.0	0.0	0.00
2	97.2	100.0	102.5	99.90	93.2	97.8	100.0	96.98	57.5	97.1	90.7	81.75	0.0	0.0	3.2	1.05
3	100.0	97.6	102.4	100.00	100.0	100.0	100.0	100.00	56.4	92.9	91.5	80.25	0.0	0.0	0.0	0.00
4	100.0	97.9	102.1	99.98	100.0	100.0	100.0	100.00	61.7	97.1	98.0	85.58	0.0	0.0	0.0	0.00
5	97.9	100.0	100.0	99.28	100.0	100.0	97.6	99.20	43.4	91.3	84.6	73.08	0.0	0.0	0.0	0.00
6	100.0	91.7	100.0	97.22	100.0	100.0	100.0	100.00	54.4	88.7	94.5	79.15	0.0	0.0	0.0	0.00
7	100.0	100.0	102.3	100.75	100.0	100.0	100.0	100.00	66.2	93.8	83.4	81.10	0.0	0.0	2.1	0.70
8	100.0	102.1	94.8	98.95	85.7	100.0	100.0	95.23	58.6	94.5	91.4	81.47	0.0	0.0	0.0	0.00
9	100.0	95.7	100.0	98.55	97.2	94.5	97.8	96.47	44.6	86.9	67.9	66.45	0.0	0.0	0.0	0.00
10	100.0	100.0	100.0	100.00	91.1	95.0	100.0	95.37	84.5	94.5	95.5	91.48	2.4	0.0	0.0	0.80
11	100.0	100.0	100.0	100.00	100.0	100.0	100.0	100.00	50.0	95.5	75.5	73.65	0.0	0.0	0.0	0.00
12	97.9	93.2	100.0	97.00	100.0	95.7	95.5	97.03	44.8	87.8	73.9	68.80	0.0	0.0	0.0	0.00
Average	99.42	98.18	100.34	99.30	97.09	98.58	98.83	98.16	56.48	92.72	86.28	78.47	0.20	0.00	0.44	0.21

a/ A is non-inoculated; B, C, and D are Rhizoctonia isolates classed, respectively, as mild, medium, and severe in pathogenicity to sugar beets, on the basis of greenhouse tests conducted previously by V. G. Pierson.

Table 2. Yield of roots for sugar beet strains inoculated with Rhizoctonia isolate C, expressed as percentage of check; basic data given as 2-plot averages. [a]

Description	Ft. Col. seed no.	Strain no.	Inoculation method and yield of roots 1	2	3	Aver.
			%	%	%	%
SP 52108-0 (LS-BR res. var.)	Acc. 1353	1	34.5	71.8	88.2	64.8
Rhiz. res. sel. (Acc. 1353 ♀)	581815-05	2	38.7	88.9	75.0	67.5
SP 55112-01 (LS-CT res. var.)	Acc. 1366	3	34.1	77.0	60.0	57.0
Rhiz. res. sel. (Acc. 1366 ♀)	581815-06	4	50.5	73.0	92.0	71.8
" " " (GWS Co. B579 ♀)	581815-019	5	20.2	82.2	66.3	56.2
" " " (" " B590 ♀)	581815-022	6	31.2	86.2	93.9	70.4
" " " (" " B525 ♀)	581815-013	7	32.4	82.6	72.6	62.5
Klein E (Europ. com'l.)	Acc. 1208	8	33.3	72.0	66.6	57.3
GW 304 (com'l.)	" 1220	9	16.2	72.0	54.9	47.7
U-I E/1 monogerm hybrid	" 1375	10	39.8	91.4	90.0	73.7
American 1	" 2071	11	35.9	71.3	76.4	61.2
SP 5831-0 (LS-BR res. var.)	" 2230	12	21.9	62.3	70.8	51.7
General mean			32.36	77.54	75.54	61.81
Calculated F-value for strains						1.77
5% point for F (for strains)						2.09
Mean of Rhizoctonia resistant selections (5 strains)						65.69
Mean of all other strains						59.05
Difference						6.64
LSD (5% point) applicable to difference immediately above						7.33
Calculated F-value for inoculation methods				26.57		
5% point for F (for inoculation methods)				19.00		
Calculated F-value for interaction, methods x strains				<1		

a/ For construction of this table "check" was considered as an average of A (non-inoculated) and B (mild isolate, essentially equivalent to A under conditions of this experiment).

Figure 1. General view of Rhizoctonia experiment R-1, Ft. Collins, Colorado, August 27, 1959, 21 days after inoculation. A block of 12, non-inoculated, 1-row plots is in left foreground; a comparable block of plots inoculated with Rhizoctonia isolate B (mild) is in right foreground (inoculation method 1).

Figure 2. Comparison of effects of 2 Rhizoctonia isolates, experiment R-1, Ft. Collins, Colorado, on August 27, 1959, 21 days after inoculation had been performed by means of method 1: foreground, isolate C; background, isolate D.

Figure 3. Varying reaction of sugar beet strains to Rhizoctonia isolate C. Picture was taken on September 26, 1959, 51 days after inoculation had been performed by means of method 1. (Exp. R-1, Ft. Collins, Colorado).

Figure 4. Typical effects of Rhizoctonia isolate C (inoculation method 1) on surviving roots, as seen at time of harvest, October 9, 1959. At left is a representative root from a non-inoculated plot. The other 7 roots constituted the entire living population, at harvest, in a comparable inoculated plot in which 20 plants were alive at time of inoculation (Aug. 6). (Exp. R-1, Ft. Collins, Colorado).

P A R T IX

DEVELOPMENT OF BASIC BREEDING MATERIAL

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SCREENING TESTS FOR BLACK ROOT RESISTANCE

Foundation Project 26

G. E. Coe C. L. Schneider

DEVELOPMENT OF BASIC BREEDING MATERIAL

(Foundation Project 26)

by G. B. Coe

Advances that have been made in interspecific hybridizations, polyploidy, disease resistance, and productivity of basic breeding material will be presented in this part of the report.

Progress of Species Hybrids

Hybrid plants obtained by crossing Beta trigyna 2n = 36 (B. corolliflora) as the female parent and tetraploid sugar beets (B. vulgaris 2n = 36) as the pollen parent were backcrossed using B. corolliflora as the backcross pollinator. Seventeen vigorous pink-hypocotyl (R) plants from the backcross were interplanted with seven tetraploid green-hypocotyl (rr) plants of B. vulgaris--six of sugar beet and one of Swiss chard. The progeny of each of the 17 plants of the backcross parent was composed of seedlings resulting from interpollination between the backcross plants and seedlings resulting from pollination by the tetraploid plants of B. vulgaris. The progenies of the tetraploid plants of sugar beet and of Swiss chard were composed of both green-hypocotyl and pink-hypocotyl seedlings. In these progenies chromosome counts were made only on the pink-hypocotyl plants. Of those examined 48 plants had 27 somatic chromosomes; 3 had 35; 112 had 36; 9 had 37; and one had 45. Those plants with 27 somatic chromosomes could have resulted from contamination by pollen from diploid sugar beets. It is likely that the others are the result of crossing between the tetraploid B. vulgaris (sugar beets and Swiss chard) and the interspecific hybrid plants. The seedlings which could be identified by hypocotyl color as interspecific hybrids were grown in the field in 1959. They had rather badly sprangled roots, not characteristic of sugar beets. The tops, however, were typical for tetraploid sugar beets. The progeny from the Swiss chard plant had leaves typical for chard. If these plants are fertile, some interesting segregations should occur in subsequent generations.

An amphidiploid line of a hybrid between B. patellaris and B. procumbens has been produced. Attempts were made to hybridize plants of this amphidiploid with tetraploid sugar beets. Seeds obtained from this cross have not been planted.

Polyploidy

In 1959 emphasis has been placed on stabilizing and testing the tetraploid lines already established as well as on determining their

performance as pollinators when mated with diploid, male-sterile, monogerm lines in the production of triploid hybrids. Stecklings of these lines were grown last summer and will produce seed in the spring of 1960. The triploid hybrid, tetraploid SLC 91 MS x SP 5481-0, and the diploid hybrid, SLC 91 MS x SP 5481-0, were produced for nursery trials in 1960.

Several lines have been tetraploidized at Beltsville, but only one inbred has given 100 percent tetraploid plants in subsequent generations. All other tetraploid lines that have been examined have contained at least a few aneuploid plants, and some lines also contained an occasional triploid.

Improvement of Breeding Material in Disease Resistance, Sugar Percent, and Root Yield

Some encouraging trends have been noted in the breeding material in the nursery tests on the Plant Industry Station, especially in the multigerm stocks. Several factors have combined to make it possible to select higher tonnage lines with improved sugar percentage.

Blackroot (Aphanomyces cochlioides) screening tests conducted in the greenhouse by C. L. Schneider have made possible the elimination of a large percentage of the susceptible progenies that would be low yielding in the nursery trials. Approximately three times as many high-tonnage progenies are now found in the same number of entries in the nursery tests as were found before the greenhouse screening test was employed. In addition to a higher proportion of good tonnage progenies, an increase in the root yield in relation to U.S. 401 has also been noted. Of 61 multigerm progenies which passed the greenhouse blackroot screening test, only 10 were below U.S. 401 in root yield. Forty-two of the highest-yielding progenies were analyzed for sugar percentage. The average performance of these 42 progenies is shown in Graph I. The performance level of U.S. 401 at Beltsville is taken as 100, and other values are shown in relation to this base. Bars above this base line indicate performances above U.S. 401, and bars below this base line indicate performances less than U.S. 401. The root yield shown is probably above inherent potential for some of the progenies, since much of their good yield undoubtedly is the result of superior resistance to blackroot and leaf spot. Similarly, the relatively high sugar percentage can partially be attributed to good leaf spot resistance. It is only as these lines are tested in an area where they are to be utilized that their average value for those environmental conditions can be assessed. The level of yield and sugar percentage in some of the progenies is sufficient to make it reasonable to assume that some actual improvement in these attributes has been achieved. The increased attention given to selection for improved sugar percentage in the last four or five years is probably responsible for any improvement in this characteristic.

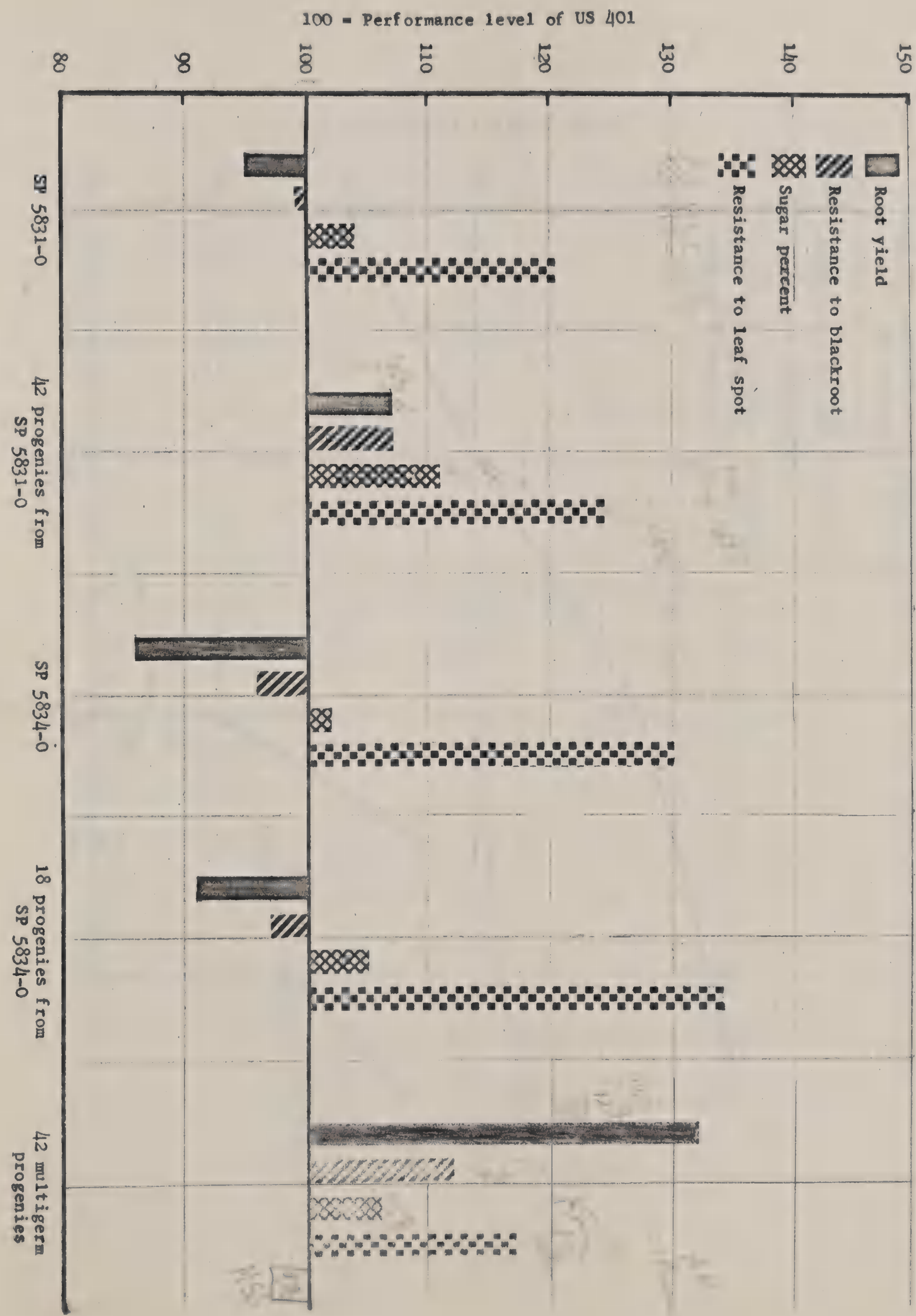
For the past two years some attention has been given to selecting for decreased amounts of non-sugar solids. Some progenies are definitely

lower in the total amount of these other solids; but progress in selecting for this attribute will be slow, since first consideration must be given to selecting for disease resistance, tonnage, and sugar content. Preliminary indications are that selecting in the present stocks for lower total non-sugar solids is feasible.

The apparent higher level of blackroot and leaf spot represents actual improvement in disease resistance; but the extent of accomplishment is difficult to determine, because the basis of appraisal varies with the severity of the disease epidemic. These multigerm stocks will be of value in improving monogerm varieties.

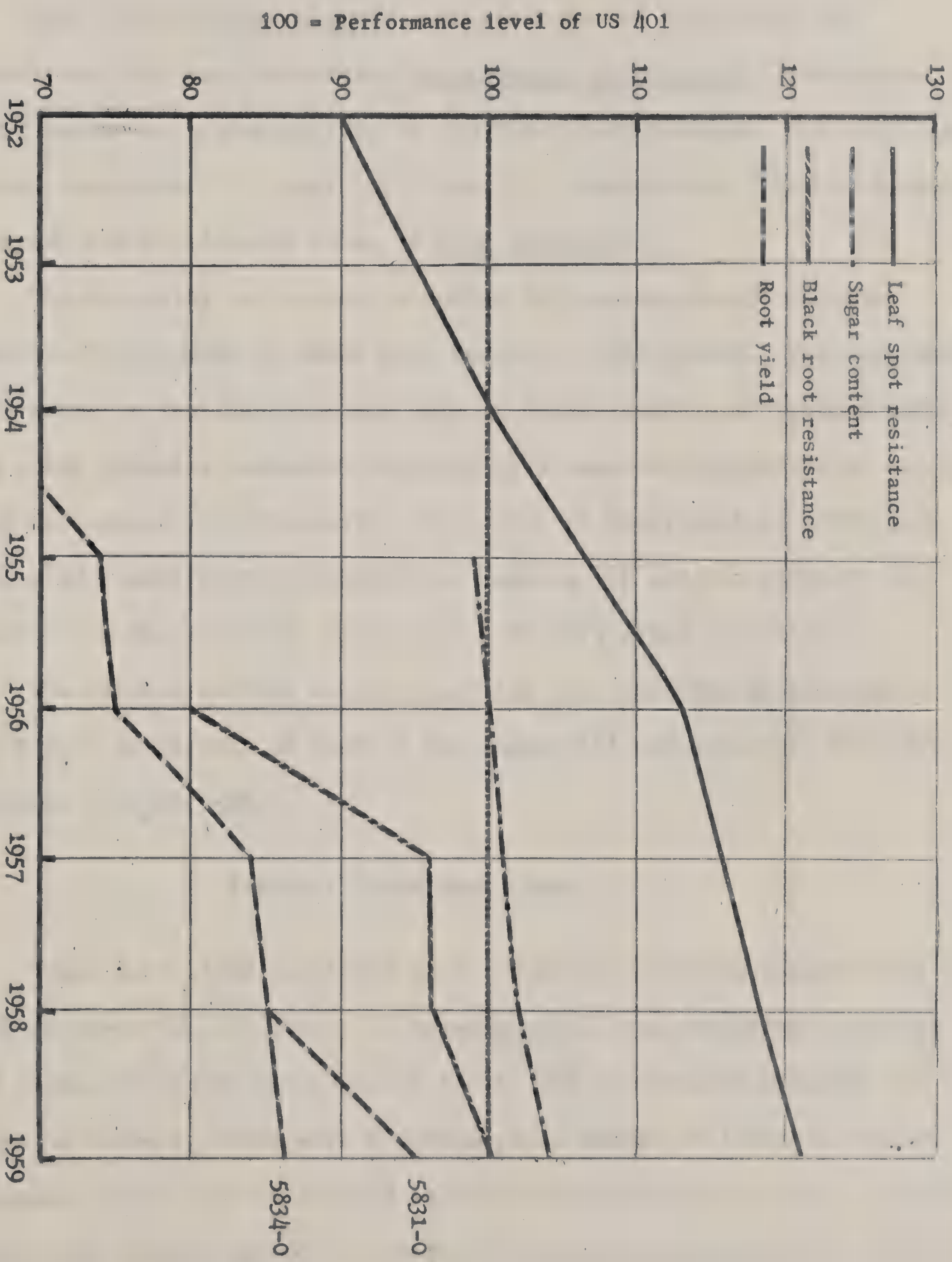
The progress that has been made in improving the more important characteristics of monogerm sugar beets is shown in Graph II. The major changes in level of blackroot resistance are a reflection of the number of backcrosses that have been made to blackroot-resistant multigerm sorts. It can be noted that the improvement in blackroot resistance is paralleled by improvement in yield. In comparison with commercial, blackroot-resistant, multigerm varieties, the monogerms already have an equal level of sugar percentage and leaf-spot resistance, but further improvement in blackroot resistance and root yield is needed.

In Graph I a comparison is shown between the performance of the monogerms SP 5831-0, SP 5834-0, the best 42 progenies of roots selected from SP 5831-0, the best 18 progenies of roots selected from SP 5834-0, and the 42 multigerm progenies previously mentioned. Although an equal number of progenies from the two monogerm lines were tested, there were many more high-yielding progenies from SP 5831-0 than from SP 5834-0. The average level of performance of the former was better in all aspects except leaf-spot resistance. SP 5831-0 has had one more backcross to blackroot-resistant stocks than has SP 5834-0; therefore, its better performance was not unexpected. The monogerm progenies of plants (132) selected from SP 5831-0 had a range in tonnage from 25 percent to 147 percent of U.S. 401. Of the 42 high-yielding progenies tested for sugar percentage, 37 were better than U.S. 401. In many of these the good sugar percentage is undoubtedly related to the better leaf-spot resistance, but it is thought that actual improvement in sugar percentage has been attained in some progenies. The average leaf-spot rating of the 132 monogerm progenies was 4.28 compared to a rating of 5.0 for U.S. 401. (The lower the rating, the higher is the resistance.) The average leaf-spot rating of the 42 high-yielding progenies was 3.99, the highest-yielding progenies being slightly better in leaf-spot resistance than the average of all the progenies in the test. Blackroot ratings were obtained on 39 of these 42 progenies. The average rating for the 39 progenies was 91.26, while the average for 128 of the total 132 progenies was 93.47, which indicates that the high-yielding progenies averaged slightly better in blackroot resistance than the lower-yielding progenies. More details of this test are given in the report by C. L. Schneider. All 39 of the high-yielding progenies tested for blackroot resistance were better in resistance than U.S. 401. These greenhouse blackroot ratings indicate marked improvement over the previous generation, which may be attributed to the fact that the roots were selected under severe blackroot exposure.



Graph I. Performance of some monogerm lines at Beltsville, 1959.

Graph 2. Improvement of monogerm sugar beets based on nursery and greenhouse tests at Beltsville, Maryland.



SCREENING TESTS FOR BLACK ROOT RESISTANCE

C. L. Schneider

Seed lots of *Beta vulgaris* were grown in the greenhouse and inoculated with pure cultures of *Aphanomyces cochlioides* to determine their degree of susceptibility to the black root disease. The seed lots tested comprised: 1) sugar beet lines developed in the U.S.D.A. breeding program, and 2) culinary forms of *Beta vulgaris*.

The screening tests were conducted in accordance with methods previously described in Sugar Beet Research, 1958 Report. The seed lots were grown in replicated 4-inch pots or 6-inch saucers of steamed soil; and after seedling emergence was complete, aqueous suspensions of zoospores were introduced into the soil. The degree of black root severity was evaluated according to the amount of damping off and the severity of symptoms on the surviving plants about 30 days after inoculation.

The disease ratings of each seed lot are expressed as the degree black root in percent of that of the commercial check variety U.S. 401, included in each test.

Tests of Sugar Beet Lines

Sugar beet lines developed in the U.S.D.A. breeding program that were screened for resistance to Aphanomyces in the greenhouse included 307 multigerm lines, 227 monogerm lines, and 73 monogerm hybrids. As shown in Table 1, there were a considerable number of lines, including monogerms, that were classified as more resistant than U.S. 401. Inferior black root ratings served as a basis for eliminating lines from additional

tests in field plots.

One group of monogerm lines (Group I) was strikingly more resistant than the second group (Group II). The reason might be attributed to the fact that the mother roots from which the Group I progenies are derived were selected from the field at the Plant Industry Station in 1958 when black root exposure was relatively severe; whereas the roots from which the Group II progenies are derived were selected in 1957 when black root exposure was considerably lighter.

Table 1. Distribution according to disease rating of sugar beet lines in greenhouse screening tests

Type of Line	No. of lines tested	Ave. Black Root Rating	Percentage of lines in each disease rating class1/						
			70	80	90	100	110	120	130
Multigerm	307	98	2.6	7.5	26.3	40.6	19.2	3.8	0
Monogerm (Group I)	128	94	0	4.7	57.0	32.0	5.4	0.9	0
Monogerm (Group II)	99	106	0	4.1	13.1	22.2	41.4	17.2	2.0
Monogerm hybrid	73	99	1.5	6.8	21.9	43.9	23.2	2.7	

1/ Rating of 100 = that of U.S. 401. The higher the numerical rating, the greater the susceptibility.

Tests of Cultivated Forms of Beta vulgaris

A survey was made to determine the extent of variability in black root susceptibility among cultivated forms of *Beta vulgaris*. Over 170 seed lots were inoculated with zoospores of *Aphanomyces cochlioides* in the greenhouse. These included: 1) Accessions from the Regional Plant Introduction Station, Ames, Iowa, comprising introductions from Afghanistan, Burma, China, Egypt, Ethiopia, India, Iran, Iraq, Lebanon, Pakistan, Syria, and Turkey; and 2) seed lots of cultivated varieties of garden beets,

mangels, and chard supplied by local seedsmen.

There were wide differences in black root susceptibility among the seed lots tested, with the majority considerably more susceptible than sugar beet variety U.S. 401 and other varieties developed for black root resistance. (Tables 2, 3, and 4)

Selection for Resistance to Aphanomyces in the Greenhouse

Studies were continued to determine the effectiveness of increasing black root resistance of sugar beet lines by selection in the greenhouse. Among the lines most resistant to Aphanomyces in inoculation tests, selections were made of the most outstanding plants that survived severe exposure to the disease. Polycross progenies of the selected plants were tested in the greenhouse, and their degree of susceptibility was compared with that of the mother line from which they were derived.

Among one group of 13 polycross progeny, three had black root ratings significantly lower than that of their parents (Table 5). Additional tests in field plots are to be made in order to evaluate more fully the effectiveness of selection for black root resistance in the greenhouse.

Table 2.
Disease Ratings of *Beta vulgaris* Seed Lots from Ames, Iowa, Plant Introduction Station, Inoculated with *Aphanomyces cochlioides* in the Greenhouse

Seed Lot No.	No. Plants Inoculated	Disease[1/] Rating	Seed Lot No.	No. Plants Inoculated	Disease[1/] Rating
PI 116808	50	114	PI 169014	118	124
116809	46	105-[2/]	169015	118	125
116810	37	121	169016	124	120
116906	22	116	169017	121	127
117113	32	124	169018	120	130
103042	45	137	169019	121	147
109038	43	119	169020	121	103
109039	27	108	169021	41	134
109040	20	125	169022	109	121
113306	71	113	169023	117	119
117114	23	125	169024	120	117
120690	30	114	169025	116	123
120692	69	99-[2/]	169027	104	114
120693	47	150	169028	50	136
120694	28	131	169029	40	129
120700	34	117	169030	48	124
120701	34	135	169031	49	99
120702	49	128	169032	49	115
120705	18	107	171504	47	110-[2/]
120706	30	117	171505	49	125
120707	32	111	171506	28	118
163176	44	120	171507	8	157
163177	--	--*	171508	--*	--*
163178	48	119	171509	40	157
163179	43	115	171512	32	126
163180	27	130	171513	8	114
163181	47	100-[2/]	171516	11	115
163182	38	122	171518	18	104
164172	49	112	171519	19	136
164292	45	111	172729	45	146
164355	19	106	172730	5	157
164363	47	116	172731	41	123
164495	24	126	172732	34	111
164524	50	116	172733	14	96
164553	21	102	172734	16	95
164659	46	113	172735	33	128
164671	--	--*	172736	40	111
164747	15	124	172737	32	111
164805	49	113	172740	42	117
164806	46	115	172741	17	113
164810	20	100-[2/]	173641	7	114
164968	15	113	173841	47	104
164978	10	110	173842	114	114
164013	49	119	173843	44	93-[2/]
165037	107	124	173844	42	113
165062	120	131	174058	42	120
165485	120	126	174059	12	107
165502	29	97	174060	20	128
167374	117	148	174061	32	128

(Continued)

Table 2. (continued)

Seed Lot No.	No. Plants Inoculated	Disease[1/] Rating	Seed Lot No.	No. Plants Inoculated	Disease[1/] Rating
PI 174062	18	102	PI 179180	99	109
174063	26	116	179844	114	115
174792	42	144	179845	117	109
175046	43	111[2/]	180409	107	113
175047	46	125	180410	116	108
175594	18	153	181011	115	115
175596	25	126	181715	96	110
175597	46	113	181716	88	111
175598	41	120	181717	81	109
175599	49	110	181718	34	128
175600	46	145	181931	30	138
175601	46	123	182144	11	124
176424	33	115	182146	33	127
176426	44	157	183211	33	119
176427	3	--*	193457	35	113
176429	46	139	193458	29	128
176432	14	130	204678	1	--*
176872	47	119	206407	38	107
176873	42	131	206408	38	114
176875	42	144	212883	39	119
177269	2	--*	215577	47	139
177271	32	129	217964	42	116
177272	105	127	220165	34	148
177273	112	131	220506	35	126
177275	92	115	220508	41	128
177276	55	109	220509	49	136
178837	79	112	220645	11	144
179173	95	113	221436	24	141
179174	60	111	222233	10	155
179175	96	116	222768	5	144
179176	103	120	223755	48	121
179178	120	125	224684	21	131
179179	23	115	229683	17	150

1/ Disease Rating: Percent of blackroot as compared with commercial sugar beet variety US 401, which = 100. The higher the rating, the greater the amount of black root. Ratings are given as means of 5 replicates.

2/ A tendency toward annualism was noted in that plants produced seed stalks within 60 days after planting and at relatively warm temperatures.

* No test because of insufficient number of plants.

Table 3. Disease ratings of cultivated types of Beta vulgaris, inoculated with Aphanomyces cochlioides in the greenhouse.

Type	Variety	Disease Rating
Garden beet	Winterkeeper	108
	Detroit Dark Red	120
	Crosby's Extra Early	127
	Early Blood Turnip	116
	Early Superb	123
	Green Top Bunching	119
	Early Wonder	120
	Perfected Detroit	122
	Flat Egyptian	109
	Crosby Egyptian	114
	Special Crosby	125
Mangel	Mammoth Long Red	124
	Giant	119
	Dark Green White Ribbed	119
Chard	Fordhook Giant	128
	Lucullus	110
	"Rhubarb"	123

Table 4. Distribution according to disease rating of Beta vulgaris seed lots inoculated with Aphanomyces cochlioides in the greenhouse.

Disease Rating Categories	No. of Seed Lots in Each Group
[1] 80	0
[2] 90	1
[3] 100 1/	13
[4] 110	46
[5] 120 2/	54
[6] 130	35
[7] 140	13
[8] 150	8
[9] 160	4
Total	174

1/ Median value of Group 3 = Disease rating of black-root-resistant variety U.S. 401.

2/ Median value of Group 5 = Disease rating of susceptible sugar beet check variety

Table 5. Comparison of black root susceptibility of sugar beet lines and progeny of plants selected from them as resistant to <u>Aphanomyces cochlioides</u> in the greenhouse.

Line from which selections were made	Selected line	Percent Black root 1/	
		Test I	Test II
553121-1		49.6	----
"	58660-1	44.8	----
"	58662-1	60.8	----
553127-1		51.9	----
"	58665-1	52.8	----
"	58667-1	46.1	----
56400-01		54.9	----
"	58677-1	54.0	----
55823-1		55.6	63.9
"	58633-1	36.9	57.6 *
"	58637-1	57.4	64.3
55887-1		45.0	67.8
"	58640-1	38.6	49.9 **
"	58641-1	49.6	61.8
"	58642-1	61.3	63.3
553106-1		53.1	62.2
"	58639-1	47.9	61.5
553108-1		57.4	69.0
"	58649-1	43.3	60.4 *
553111-1		53.7	65.3
"	58653-1	64.2	66.2
LSD (P = .05)			7.3 *
(P = .01)			9.7 **

1/ Percentages converted to angles in degrees.

PART X

DEVELOPMENT AND EVALUATION OF SUGAR BEET VARIETIES SUITABLE FOR THE GREAT LAKES REGION

Breeding to Combine Resistance to Leaf Spot, Black Root, and Curly Top in High Quality Lines and Productive Varieties

- -

Evaluation of Miscellaneous Varieties

Foundation Project 26

Dewey Stewart
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F. V. Owen
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G. J. Hogaboam
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Cooperators conducting field tests:

- Farmers & Manufacturers Beet Sugar Association
- American Crystal Sugar Company
- The Great Western Sugar Company
- Spreckels Sugar Company
- Canada and Dominion Sugar Company, Ltd.
- National Sugar Manufacturing Company
- Northern Ohio Sugar Company
- Colorado Agricultural Experiment Station
- Michigan Agricultural Experiment Station
- New Mexico Agricultural Experiment Station
- Tribune Branch Station, Kansas Agricultural Experiment Station

Development and Evaluation of Varieties Suitable for the Great Lakes Region, and Breeding to Combine Resistance to Leaf Spot and Curly Top[1]

The development of monogerm varieties and hybrids is being emphasized in the sugar beet research conducted in the Great Lakes region. In addition to monogermness, other characters--such as yield of roots, high quality, and resistance to leaf spot and black root--are major objectives of the breeding program. In some sugar beet districts, where damage caused by curly top has been greatly reduced through the use of resistant varieties, leaf spot apparently is increasing in severity; consequently, there is a growing need for varieties that are resistant to both leaf spot and curly top. Results of field trials with varieties that are resistant to both leaf spot and curly top are included in Part II as well as in Part X.

Cooperative Tests in the Great Lakes Region.--The cooperative field tests in Michigan, Ohio, and Ontario, Canada, were conducted chiefly to evaluate four monogerm hybrids, a monogerm synthetic variety, and US 401, a multigerm variety widely used in the Great Lakes region. The summary and statistical analysis of results from six Latin Square tests are given on page 234. Data pertaining to these six varieties, which occurred in other tests that differed in experimental design or in entry numbers (pp. 248, 250, and 252), have not been included in the summary. Leaf spot was reported as severe at Malinta, moderate at Sebewaing, and only slight or negligible in the other tests included in the summary. Except for the test at Croswell, where black root was reported as moderate, this disease was a minor factor in varietal performance.

Attention is called to the performances of the monogerm hybrids SL 108MS X SP 5460-0, SL 117MS X SP 5481-0, and SL 117MS X SP 5714-0. These are hybridizations in which a male-sterile monogerm line is used as the principal seed bearer and a complementary multigerm variety is employed as the pollinator, with a resultant low percentage of multigerm seed in the commercial hybrid. The two monogerm lines SL 108MS and SL 117MS were developed at the Salt Lake City Field Station where discriminate selection could not be applied for leaf spot and black root resistance. The multigerm varieties SP 5460-0, SP 5481-0, and SP 5714-0, which were developed in the breeding research conducted at the Plant Industry Station and in the Great Lakes region, are among the better sorts in resistance to leaf spot and black root. Comparisons of varietal performances based on average values given on page 234 are of interest. The three commercial monogerm hybrids did not differ significantly in either sucrose percentage or acre yield of roots. If comparisons are made between each of the three monogerm hybrids and US 401, it is found that the monogerm hybrids are significantly higher in sucrose percentage and do not differ significantly from US 401 in gross sugar production.

Except for sucrose percentage below that of SL 108MS X SP 5460-0, the monogerm hybrid SP 58169-01 did not differ significantly from the three

[1] Discussion by Dewey Stewart

commercial hybrids in root yield, sucrose percentage, or gross sugar production. Furthermore, SP 58169-01 did not differ significantly from US 401 in any of these same attributes.

The monogerm variety SP 5834-0 is known to be about equal to US 401 in leaf spot resistance. The average sucrose percentage of this variety, as summarized on page 234, is slightly above that of US 401, but the acre yields of roots and of gross sugar are significantly below that of US 401, the difference being about 11 percent. In other tests not included in the summary, the monogerm varieties SP 5831-0, SP 5832-0, SP 5835-0, and SP 5836-0, which were developed in the same program of breeding, show about the same level of performance as SP 5834-0, except for a slight improvement in sucrose percentage.

Although monogerm lines are being emphasized in the breeding research, there are several multigerm sorts which require further field evaluation. A number of these multigerm lines and varieties are entries in tests conducted at East Lansing, Michigan, by Hogaboam and Bockstahler (pp. 250, 252), and in tests reported by the Northern Ohio Sugar Company (pp. 254, 257). Attention is called to the performance of a leaf-spot-resistant variety, SP 5822-0, which was developed by G. E. Coe from the interpollination of seven clones. In the tests reported by the Northern Ohio Sugar Company, SP 5822-0 was highest in gross sugar production and in thin-juice apparent purity. In the North Nursery Test at East Lansing, where a combination of unfavorable weather and disease damage had a profound effect on sucrose percentage, SP 5822-0 was the only entry, among 36, producing roots that even approached marketable quality. In this test, Synthetic Check (European) and SP 5822-0 had approximately the same yield of roots, but the sucrose percentages were 5.8 and 11.4, respectively; and the sucrose reading of US 401 was 8.0 percent. Eight pounds of seed of SP 5822-0 will be available for increase and utilization in 1960. It is of interest to note that SP 571850-00, a storage-rot-resistant selection by Gaskill, was significantly above all entries, except SP 5481-0 and SP 5810-0, in the North Nursery Test at East Lansing.

Leaf Spot and Curly Top Resistance.--A few varieties carrying resistance to both leaf spot and curly top have been included in tests of 1959. The performances of SP 571-0, SP 57102-0, SP 57109-0, SP 58100-04, and SP 57102-0 have been given in Part II and Part X. Some of these, notably SP 571-0 and SP 57102-0, have been used as pollinators in the production of hybrid seed. The commercial monogerm hybrid SLC 122MS X SP 571-0 was significantly higher than US 35 in root yield and gross sugar production in a test conducted by the American Crystal Sugar Company in Texas (p. 266) and gave excellent performance in a test at Taylorsville, Utah (p. 24).

Miscellaneous Varieties.--Breeder seed and varieties have been made available by the Hilleshög Sugar Beet Breeding Institute, Landskrona, Sweden, and by breeders in Poland and Austria. These accessions were included in tests by Gaskill (p. 270) and by Hogaboam (p. 271) to determine their level of leaf spot resistance rather than root yield and sucrose percentage. The Russian monogerm introductions in tests by Gaskill and Hogaboam are discussed in Part XI of this Report.

Breeder seed, inbred lines, hybrids, etc., included in field tests reported in Part X

Seed Designation	Reported on Page No.:	Salient Characters
SP 5460-0 MM (WC 6327)	250, 252	Leafspot-blackroot res.
SP 5481-0 MM (Lot 801)	250-257,270,271	Leafspot-blackroot res.
SP 5510-0 MM (WC 7370)	250-257	Leafspot-blackroot res.
SP 55600-01 MM	254,256,257	Leafspot-blackroot res.
SP 5611-0 MM	254,256,257	Leafspot-blackroot res.
SP 571-0 MM (U-I incr.)	250,252,260, 264,266	Leafspot-curly top res.
SP 5713-0 MM (WC 8306)	250-252,272	Leafspot-blackroot res.
SP 5714-0 MM (WC 8220)	250-257,272	Leafspot-blackroot res.
SP 5716-0 MM (WC 8308)	250-257,272	Leafspot-blackroot res.
SP 5724-0 MM	254-256,257	Leafspot-blackroot res.
SP 5733-0 mm (WC 8310)	250-257	Leafspot-blackroot res.
SP 57102-0 MM (U-I incr.)	250-252,260, 264,266	Leafspot-curly top res.
SP 57109-0 MM	262	Leafspot-curly top res.
SP 571850-00 MM (WC 8309)	250-257	Storage rot res.
SP 5822-0 MM	250-257	Leafspot-blackroot res.
SP 5831-0 mm	250,252	Leafspot-blackroot res.
SP 5832-0 mm	270	Leafspot-blackroot res.
SP 5834-0 mm	234-252,268	Leafspot-blackroot res.
SP 5835-0 mm	250,252	Leafspot-blackroot res.
SP 5836-0 mm	250,252,268	Leafspot-blackroot res.
SP 5840-0 mm	250,252	Leafspot-blackroot res.
SP 5850-01 MM	250-257	Bolting res. sel. LS-BR
SP 5851-01 MM	250,252	Bolting res. sel. LS-BR
SP 5852-01 MM	250,252	Leafspot-blackroot res.

Seed Designation	Reported on Page No.:	Salient Characters
SP 58100-04 MM	262	Leafspot-curly top res.
SP 58101-0 MM	250,252,260	Sel. from US 104 LS-CT
SP 58169-01 Mm	234-252	Leafspot-blackroot res.
SP 591101-0 mm	270	Storage rot res.
SLC 20 mm Klein E	261	
SL 91MS x GW674	260	SL91MS is monogerm
SL 108MS x 5460-0	234-252	Com'l. hyb. (mm x MM)
SL 117MS x 5481-0	234-252	Hybrid (mm x MM)
SL 117MS x 571-0	250,252,264,266	Hybrid (mm x MM)
SL 117MS x 5714-0	234-252	Hybrid (mm x MM)
SL 117MS x 5714-0	250,252	Hybrid (mm x MM)
SL 117MS x 5716-0	250,252	Hybrid (mm x MM)
SL 117MS x 57102-0	250,252,264,266	Hybrid (mm x MM)
SLC 117 MS x Am. 56-407-0	266	Hybrid (mm x MM)
SL 119MS x 5714-0	250,252	Hybrid (mm x MM)
SL 119 MS x 5733-0	250,252	Hybrid (mm x mm)
SL 119 MS x (601aa x 566-0)	250,252	Hybrid (mm x mm)
SL 119 MS x (601aa x 558-0)	250,252	Hybrid (mm x mm)
SL 122 x 571-0	250,252,266	Hybrid (mm x MM)
SL 122 x 57102-0	250,252,264,266	Hybrid (mm x MM)
US 22/4	262	Curly top res.
US 35	266	Curly top res.
US 56/2	272	Bolting res.
US 400	272	Leafspot-blackroot res.
US 401 (Lot 810)	234-257,270,271	Leafspot-blackroot res.

Seed Designation	Reported on Page No.:	Salient Characters
Acc. 1327 Syn. Ch. MM	250,252	European
PI 254575 mm	270,271	Russian monogerm
PI 254576 mm	"	"
EL 70 (mm lines x Ac. 345)	248	Hybrid (mm x MM)
EL 71 (mm lines x 53AB1-32)	"	"
Am. 58-602 mm Am. 3S	268	Monogerm (Waseca)
Am. 58-603 mm Am. 3S	"	Monogerm (Blue Earth)
Am. 58-809 mm Am. 3S	"	SLC 15 x Am 56-601
Am. 58-305	"	SLC 3 x Am. 3N
Am. 58-608 mm Am 3S	"	Monogerm backcross
American 2	264	Commercial
American 3N	268	Commercial
GW674-57AD	260	
GW 674 x US 401	254-257	
U-I E114 monogerm	262	
CLR 2N (Poland)	270,271	Leafspot res.
CLR Poly (Poland)	"	"
Janasz AJ_1 (Poland)	"	High sucrose
Udycz 2A (Poland)	"	"
4 N D (H 3609)	270,271	Hilleshög Inst., Sweden
4 N I (E 7685)	"	"
4 N J (H 19)	"	"
4 N Z (H 3790)	"	"
4 N DP (H 5828)	"	"
4 N UP (H 3958)	"	"
Tetra (H 3611)	"	"
Maribo P-A1	264	from Sedlmayr
Maribo P-A3	"	"
Maribo A-5	"	"
Maribo P-A10	"	"
Polybeet	262	
Klein E	261,271	
National Blend	262	

Summary of 6 - 6 X 6 latin square experiments conducted by F & M member sugar companies. Year: 1959

Locations: Centralia, Ontario; Wallaceburg, Ontario; Malinta, Ohio; Sebewaing, Michigan; LaPorte, Michigan; and Croswell, Michigan.

(See pages 236, 238, 240, 242, 244, and 246)

(Results given as 6 plot averages)

Variety and Description		Acre-Yield Gross Sugar	Acre-Yield Roots	Sucrose	Purity	@Beets per 100' of row
		Pounds	Tons	Percent	Percent	Number
SL 108MS X 5460-0	Mm	5627 1	19.38 2	14.462 1	87.423 2	82
SL 117MS X 5481-0	Mm	5363 3	19.05 4	14.082 3	87.328 3	86
SL 117MS X 5714-0	Mm	5177 5	18.29 5	14.135 2	87.898 1	83
58169-01 (mm lines X 5481-0 5510-0)	Mm	5226 4	19.15 3	13.715 4	86.528 5	79
5834-0 Syn. Var.	mm	4768 6	17.51 6	13.702 5	85.970 6	74
US 401 (Lot 810)	MM	5367 2	19.88 1	13.527 6	86.888 4	79
General Mean		5255	18.88	13.937	87.005	80
S.E. Variety Mean		150.97	0.4196	0.14862	0.16310	2.00
" " " as % Gen. Mean		2.87	2.22	1.07	0.19	2.49
Diff. req. for sig. (Odds 19:1)		427	1.19	0.421	0.492	6

Variance Table

Latin Square Analysis

Source of variation	D/F 6 Exp	D/F 4 Exp	Mean Squares Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
Between locations	5	3	11,340,334	138.15888	15.572741	47.850902	210
Between varieties	5	5	488,029	4.2850	0.730161	1.910330	106
Variety X Location	25	15	136,758	1.0565	0.132604	0.106377	24
Total	35	23					
Calculated F. value	5/25	5/15	3.57*	4.06**	5.51**	17.96**	4.44**
Req. for sig. 5% level	5/25	5/15	2.60	2.60	2.60	2.90	2.60
" " " 1% "	5/25	5/15	3.86	3.86	3.86	4.56	3.86

@summary of only 4 experiments as purities were not run in Canada.

AGRONOMIC EVALUATION TEST - 1959

Conducted by: M. R. Berrett.

Location: Harold Gremel farm, Sebewaing, Michigan.

Cooperation: F & M Beet Sugar Association, Michigan Sugar Company.

Date of Planting: April 25, 1959.

Date of Harvest: November 7, 1959.

Experimental Design: 6 x 6 Latin square.

Size of plots: 4 rows x 70 feet, 28 inches between rows.

Harvested Area per Plot for Root Yield: 2 center rows x 68 feet, hand topped.

Samples for Sucrose Determinations: Two eight-beet samples selected at random.

Stand Counts: Harvested beets counted when weighed.

Recent Field History: 1958 - Navy Beans 350# 5-20-20 with Manganese; 1957 - Pasture, manured; 1956 - Hay; 1955 - Oats seeded 350# 5-20-20 with Manganese.

Fertilization of Beet Crop: 650# 6-24-12 under the row with Manganese and Boron; 125# 10-40-0 with the seed, 8 tons of manure per acre.

Leafspot Exposure: Moderate.

Black Root Exposure: Slight.

Other Diseases and Pests: None.

Soil and Seasonal Conditions: Moist seedbed, good weather conditions throughout the season.

Reliability of Test: Excellent.

Cooperator: F. & M. Beet Sugar Association., Michigan Sugar Co. Year: 1959

Location : Harold Gremel farm, Sebewaing, Michigan. Expt.: 5904

(Results given as 6 plot averages)

Variety and Description		Acre-Yield Gross Sugar	Acre-Yield Roots	Sucrose	Purity	Beets per 100' of row
		Pounds	Tons	Percent	Percent	Number
SL 108MS X 5460-0	Mm	6126	24.60	12.50	83.28	75
SL 117MS X 5481-0	Mm	6071	26.12	11.65	83.34	88
SL 117MS X 5714-0	Mm	5610	23.83	11.78	84.02	82
58169-01 (mm lines X 5481-0 5510-0)	Mm	5911	25.25	11.75	82.06	76
5834-0 Syn. Var.	mm	5723	24.02	11.92	82.09	81
US 401 (Lot 810)	MM	5902	26.38	11.22	82.59	79
General Mean		5891	25.03	11.80	82.90	80
S.E. Variety Mean		215.7	.9084	0.2537	0.7499	3.05
" " " as % of Gen. Mean		3.66	3.63	2.15	0.90	3.81
Diff. req. for sig. (Odds 19:1)		NS	NS	NS	NS	NS

Variance Table

Latin Square Analysis

Source of variation	D/F	Mean Squares: Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
Between columns	5	410,667	9.2730	0.6649	1.6061	197
Between rows	5	1,383,817	23.5433	2.3089	4.9968	29
Between varieties	5	235,011	6.8347	1.0429	3.6673	132
Remainder - Error	20	279,261	4.9524	0.3863	3.3752	56
Total	35					
Calculated F. value	5/20	negative	1.38^{NS}	2.70^{NS}	1.09^{NS}	2.37^{NS}
Req. for sig. 5% level	5/20	2.71	2.71	2.71	2.71	2.71
" " " 1% "	5/20	4.10	4.10	4.10	4.10	4.10

AGRONOMIC EVALUATION TEST - 1959

Conducted by: M. R. Berrett, G. E. Nichol.

Location: Ross Thayer farm, LaPorte, Michigan.

Cooperation: F & M Beet Sugar Association, Monitor Sugar Division.

Date of Planting: May 2, 1959.

Date of Harvest: October 28, 1959.

Experimental Design: 6 x 6 Latin square.

Size of plots: 4 rows x 70 feet, 28 inches between rows.

Harvested Area per Plot for Root Yield: 2 center rows x 68 feet, hand topped.

Samples for Sucrose Determinations: Two eight-beet samples selected at random.

Stand Counts: Harvested beets counted when weighed.

Recent Field History: 1958 - Clover; 1957 - Wheat seed 300# 5-20-20, 200# 12-12-12 Spring; 1956 - Beans.

Fertilization of Beet Crop: 400# 6-24-12.

Leafspot Exposure: Slight.

Black Root Exposure: Slight.

Other Diseases and Pests: None.

Soil and Seasonal Conditions: Moist seedbed, good weather conditions throughout the season.

Reliability of Test: Excellent.

Cooperator: F. & M. Beet Sugar Association, Monitor Sugar Division. Year: 1959

Location : Ross Thayer farm, LaPorte, Michigan. Expt.: 5905

(Results given as 6 plot averages)

Variety and Description		Acre-Yield Gross Sugar	Acre-Yield Roots	Sucrose	Purity	Beets per 100' of row
		Pounds	Tons	Percent	Percent	Number
SL 108MS X 5460-0	Mm	7626	23.28	16.38	88.38	88
SL 117MS X 5481-0	Mm	7029	21.88	16.07	88.42	91
SL 117MS X 5714-0	Mm	7067	22.04	16.02	88.85	89
58169-01 (mm lines X 5481-0 / 5510-0)	Mm	6637	22.09	15.03	87.36	74
5834-0 Syn. Var.	mm	5846	19.93	14.68	86.85	69
US 401 (Lot 810)	MM	7021	22.64	15.52	87.78	80
General Mean		6872	21.98	15.62	87.95	82
S.E. Variety Mean		162.3	0.5605	0.1585	.6056	3.4
" " " as % of Gen. Mean		2.36	2.55	1.01	0.69	4.13
Diff. req. for sig. (Odds 19:1)		459	1.59	0.45	NS	10

Variance Table

Latin Square Analysis

Source of variation	D/F	Mean Squares: Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
Between columns	5	377,207	3.6186	0.4347	4.1472	192
Between rows	5	1,081,952	11.7059	0.1100	4.6160	194
Between varieties	5	2,113,333	7.6325	2.6060	3.3559	496
Remainder - Error	20	158,081	1.8851	0.1508	2.2008	69
Total	35					
Calculated F. value	5/20	13.37**	4.05*	17.28**	1.52^{NS}	7.22**
Req. for sig. 5% level	5/20	2.71	2.71	2.71	2.71	2.71
" " " 1% "	5/20	4.10	4.10	4.10	4.10	4.10

AGRONOMIC EVALUATION TEST - 1959

Conducted by: M. R. Berrett.

Location: Reed Gordon farm, Croswell, Michigan.

Cooperation: F & M Beet Sugar Association, Michigan Sugar Company.

Date of Planting: May 15, 1959.

Date of Harvest: November 12, 1959.

Experimental Design: 6 x 6 Latin square.

Size of plots: 4 rows x 70 feet, 28 inches between rows.

Harvested Area per Plot for Root Yield: 2 center rows x 68 feet.

Samples for Sucrose Determinations: Two ten-beet samples selected at random.

Stand Counts: Harvested beets counted when weighed.

Recent Field History: 1958 - Hay 10 Tons Manure per acre; 1957 - Hay; 1956 - Oats 300# per acre 6-24-12.

Fertilization of Beet Crop: 500# 6-24-12 - 45#N applied in the fall of 1958.

Leafspot Exposure: Slight.

Black Root Exposure: Moderate.

Other Diseases and Pests: None.

Soil and Seasonal Conditions: Moist seedbed, Excess rainfall throughout growing season.

Realiability of test: Fair.

Cooperator: F. & M. Beet Sugar Association, Michigan Sugar Co. Year: 1959

Location: Reed Gordon farm, Croswell, Michigan. Expt.: 5907

(Results given as 6 plot averages)

Variety and Description		Acre-Yield Gross Sugar	Acre-Yield Roots	Sucrose	Purity	Beets per 100' of row
		Pounds	Tons	Percent	Percent	Number
SL 108MS X 5460-0	Mm	6160	18.78	16.42	90.24	73
SL 117MS X 5481-0	Mm	6550	20.26	16.17	89.37	80
SL 117MS X 5714-0	Mm	5610	16.94	16.53	90.40	74
58169-01 (mm lines X $\frac{5481-0}{5510-0}$)	Mm	5760	18.53	15.55	88.82	73
5834-0 Syn. Var.	mm	4480	15.08	14.88	87.88	54
US 401 (Lot 810)	MM	5912	19.16	15.42	89.36	65
General Mean		5746	18.13	15.83	89.35	70
S.E. Variety Mean		253.1	0.7632	0.2035	0.4564	3.6
" " " as % of Gen. Mean		4.40	4.21	1.29	0.51	5.15
Diff. req. for sig. (Odds 19:1)		716	2.16	.58	1.29	10

Variance Table

Latin Square Analysis

Source of variation	D/F	Mean Squares: Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
Between columns	5	1,128,695	12.0032	0.3618	123.2500	123
Between rows	5	1,298,606	13.2855	0.5971	185.3833	185
Between varieties	5	2,960,683	20.3031	2.5171	489.9833	490
Remainder - Error	20	384,397	3.4953	0.2486	77.8833	78
Total	35					
Calculated F. value	5/20	7.70**	5.81**	10.13**	4.15**	6.29**
Req. for sig. 5% level	5/20	2.71	2.71	2.71	2.71	2.71
" " " 1% "	5/20	4.10	4.10	4.10	4.10	4.10

AGRONOMIC EVALUATION TEST - 1959

Conducted by: M. R. Berrett.

Location: Robert Hoff farm, Malinta, Ohio.

Cooperation: F & M Beet Sugar Association, Buckeye Sugars Inc.

Date of Planting: April 23, 1959.

Date of Harvest: October 19, 1959.

Experimental Design: 6 x 6 Latin square.

Size of plots: 4 rows x 70 feet, 32 inches between the rows.

Harvested Area per Plot for Root Yield: 2 center rows x 68 feet, hand topped.

Samples for Sucrose Determinations: Two ten-beet samples selected at random.

Stand Counts: Harvested beets counted when weighed.

Recent Field History: 1958 - Corn 700# 5-20-10; 1957 - Clover; 1956 - Wheat seeded 400# 12-12-12.

Fertilization of Beet Crop: 550# 0-20-20 plowed down; 150# 5-20-10 at planting time; 50# N applied as anhydrous ammonia sidedressed.

Leafspot Exposure: Severe.

Black Root Exposure: Slight.

Other Diseases and Pests: None.

Soil and Seasonal Conditions: Moist seedbed, good weather conditions throughout the season.

Reliability of Test: Excellent.

Cooperator: F. & M. Beet Sugar Association, Buckeye Sugars, Inc. Year: 1959

Location: Robert Hoff farm, Malinta, Ohio. Expt.: 5903

(Results given as 6 plot averages)

Variety and Description		Acre-Yield Gross Sugar	Acre-Yield Roots	Sucrose	Purity	Beets per 100' of row
		Pounds	Tons	Percent	Percent	Number
SL 108MS X 5460-0	Mm	6293	22.16	14.18	87.79	88
SL 117MS X 5481-0	Mm	5802	21.23	13.65	88.18	87
SL 117MS X 5714-0	Mm	6037	21.63	13.97	88.32	90
58169-01 (mm lines X 5481-0 / 5510-0)	Mm	5602	21.27	13.20	87.87	89
5834-0 Syn. Var.	mm	5043	18.31	13.75	87.06	75
US 401 (Lot 810)	MM	6081	23.00	13.17	87.82	86
General Mean		5810	21.27	13.65	87.84	86
S.E. Variety Mean		199.8	0.7617	0.1654	1.0003	3.1
" " " as % of Gen. Mean		3.44	3.58	1.21	1.14	3.58
Diff. req. for sig. (Odds 19:1)		566	2.16	0.47	NS	9

Variance Table

Latin Square Analysis

Source of variation	D/F	Mean Squares: Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
Between columns	5	1,657,009	14.1260	.5729	18.0298	452
Between rows	5	841,735	8.6263	.6069	0.9929	86
Between varieites	5	1,187,279	15.2436	.9969	1.1513	175
Remainder-Error	20	239,688	3.4822	.1643	6.0055	57
Total	35					
Calculated F. value	5/20	4.95**	4.38**	6.07**	negative	3.08*
Req. for sig. 5% level	5/20	2.71	2.71	2.71	2.71	2.71
" " " 1% "	5/20	4.10	4.10	4.10	4.10	4.10

AGRONOMIC EVALUATION TEST - 1959

Conducted by: C. E. Broadwell.

Location: Wallaceburg Experimental Farm, Wallaceburg, Ontario, Canada.

Cooperation: C & D Sugar Company.

Date of Planting: June 5, 1959.

Date of Harvest: September 30, 1959.

Experimental Design: 6 x 6 Latin square, design #2.

Size of plots: 70 feet long, 24 inches wide.

Harvested Area per Plot for Root Yield: 2 center rows x 70 feet, hand topped.

Samples for Sucrose Determinations: Ten beets selected at random.

Stand Counts: Harvested beets counted when weighed.

Recent Field History: Canning Corn - 1959; Wheat & Red Clover plowed down - 1958.

Fertilization of Beet Crop: 200-4-24-20 with drill, 200" ammonium nitrate and disced in 500# 0-20-20 plowed down in fall.

Leafspot Exposure: None.

Black Root Exposure: None.

Other Diseases and Pests: None.

Soil and Seasonal Conditions: Dry.

Reliability of Test: Good.

Cooperator: C. & D. Sugar Company and F. & M. Beet Sugar Association. Year: 1959

Location: C. & D. Experimental farm, Wallaceburg, Ontario Expt.: 5902

(Results given as 6 plot averages)

Variety and Description		Acre-Yield Gross Sugar	Acre-Yield Roots	Sucrose	Beets per 100' of row
		Pounds	Tons	Percent	Number
SL 108MS X 5460-0	Mm	3160	12.46	12.62	80
SL 117MS X 5481-0	Mm	2904	11.54	12.55	81
SL 117MS X 5714-0	Mm	2982	11.85	12.53	77
58169-01 (mm lines X 5481-0 / 5510-0)	Mm	3354	13.38	12.53	81
5834-0 Syn. Var.	mm	3254	12.81	12.70	75
US 401 (Lot 810)	MM	3150	12.64	12.43	80
General Mean		3134	12.45	12.56	79
S.E. Variety Mean		166.7	0.6027	0.2206	2.1
" " " as % Gen. Mean		5.33	4.84	1.76	2.69
Diff. req. for sig. (Odds 19:1)		NS	NS	NS	NS

Variance Table

Latin Square Analysis

Source of variation	D/F	Mean Squares Gross Sugar	Mean Squares Roots	Mean Squares Sucrose	Mean Squares Beets per 100' of row
Between columns	5	307,761	2.7230	.7018	108
Between rows	5	362,115	3.7342	.5664	61
Between varieties	5	167,931	2.6640	.0484	31
Remainder - Error	20	166,762	2.1798	.2921	27
Total	35				
Calculated F. value	5/20	1.01	1.22	negative	1.15
Req. for sig. 5% level	5/20	2.71	2.71	2.71	2.71
" " " 1% "	4.10	4.10	4.10	4.10	4.10

AGRONOMIC EVALUATION TEST - 1959

Conducted by: C. E. Broadwell.

Location: Blair Brothers, Centralia, Ontario, Canada.

Cooperation: C & D Sugar Company.

Date of Planting: May 18, 1959.

Date of Harvest: September 28, 1959

Experimental Design: 6 x 6 Latin square, design #1.

Size of plots: 70 feet long, 24 inches wide, planted with Planet Jr.

Harvested Area per Plot for Root Yield: 2 center rows x 70 feet, hand topped.

Samples for Sucrose Determinations: Ten beets selected at random.

Stand Counts: Harvested beets counted when weighed.

Recent Field History: Spring Grain.

Fertilization of Beet Crop: 300# 3-15-10 Broadcast; 300# 3-15-10 with seed.

Leafspot Exposure: Slight.

Black Root Exposure: None.

Other Diseases and Pests: None.

Soil and Seasonal Conditions: Wet.

Reliability of Test: Good.

Cooperator: C. & D. Sugar Company and F. & M. Beet Sugar Association. Year: 1959

Location: Blair Brothers farm, Centralia, Ontario, Canada Expt.: 5901

(Results given as 6 plot averages)

Variety and Description		Acre-Yield Gross Sugar	Acre-Yield Roots	Sucrose	Beets per 100' of row
		Pounds	Tons	Percent	Number
SL 108MS X 5460-0	Mm	4395	14.99	14.67	89
SL 117MS X 5481-0	Mm	3824	13.25	14.40	88
SL 117MS X 5714-0	Mm	3755	13.43	13.98	85
58169-01 (mm lines X 5481-0/5510-0)	Mm	4090	14.39	14.23	84
5834-0 Syn. Var.	mm	4262	14.92	14.28	87
US 401 (Lot 810)	MM	4136	15.45	13.40	84
General Mean		4077	14.41	14.16	86
S.E. Variety Mean		110.6	.3562	.2004	1.7
" " " as % of Gen. Mean		2.71	2.52	1.42	1.98
Diff. req. for sig. (Odds 19:1)		313	1.01	0.57	NS

Variance Table

Latin Square Analysis

Source of variation	D/F	Mean Squares: Gross Sugar	Roots	Sucrose	Beets per 100' of row
Between columns	5	177,214	1.1792	0.3924	56
Between rows	5	278,056	4.8080	0.1598	34
Between varieties	5	367,504	4.7868	1.1324	28
Remainder - Error	20	73,355	0.7616	0.2411	18
Total	35				
Calculated F. value	5/20	5.01**	6.29**	4.70**	1.53 NS
Req. for sig. 5% level	5/20	2.71	2.71	2.71	2.71
" " " 1% "	5/20	4.10	4.10	4.10	4.10

AGRONOMIC EVALUATION TEST - 1959

Conducted by: L.N. Shepherd.

Location: Michigan State University Muck Experimental Farm, Bath, Michigan.

Cooperation: Michigan Agricultural Experiment Station, Soils Department.

Date of Planting: May 2, 1959.

Date of Harvest: November 3, 1959.

Experimental Design: 8 x 8 Latin square.

Size of Plots: 8 rows x 22 feet, 32 inches between rows.

Harvested Area per Plot for Root Yield: 4 inner rows x 15 feet.

Samples for Sucrose Determinations: Two ten-beet samples selected at random.

Stand Counts: No counts made. Good stands in most plots.

Recent Field History: 1957 & 1958 - Carrots.

Fertilization of Beet Crop: 500# 5-20-10 and 10# Mn, 40# Borax, two inches below seed. 300# K_2O (as KCl) broadcast before planting.

Leafspot Exposure: None.

Black Root Exposure: None.

Other Diseases and Pests: None.

Soil and Seasonal Conditions: Houghton Muck 80% organic. pH 6.2. Ample moisture, wet fall.

Realiability of Test: Good.

Cooperator: Michigan Agr. Expt. Station, Soils Dept. Year: 1959

Location: MSU Muck Experimental Farm, Bath, Michigan.

(Results given as 8 plot averages)

Variety and Description		Acre-Yield Gross Sugar	Acre-Yield Roots	Sucrose	Purity
		Pounds	Tons	Percent	Percent
SL 108MS X 5460-0	Mm	8213	29.7	13.8	84.05
SL 117MS X 5481-0	Mm	8247	30.9	13.3	85.45
SL 117MS X 5714-0	Mm	7542	27.9	13.5	84.81
58169-01 (mm lines X 5481-0 5510-0)	Mm	7506	29.3	12.8	82.68
5834-0 Syn. Var.	mm	7156	27.4	13.0	83.18
US 401 (Lot 810)	MM	7620	29.6	12.9	83.51
Kohls 59 EL 70(mm lines X A6345	Mm	7522	27.6	13.6	84.42
Kohls 59 EL 71(mm linesX53AB1-32	Mn	7526	26.9	14.0	84.16
General Mean		7667	28.65	13.37	84.03
S.E. Variety Mean		142.96	0.9054	0.1906	0.9104
" " " as % Gen. Mean		1.86	3.16	1.43	1.08
Diff. req. for sig.(Odds 19:1)		408	2.6	.54	NS

Variance Table

Latin Square Analysis

Source of variation	D/F	Mean Squares Gross Sugar	Roots	Sucrose	Purity
Between columns	7	5,627,437	88.35	.75	12.78
Between rows	7	1,462,469	8.18	1.12	11.14
Between varieties	7	1,126,785	16.07	1.51	6.40
Remainder-error	42	496,109	6.56	.29	6.63
Total	63				
Calculated F value		2.27*	2.45*	5.21**	NS
Req. for sig. 5% level	7/42	2.24	2.24	2.24	
" " " 1% "	7/42	3.10	3.10	3.10	

BLACK ROOT NURSERY TEST - 1959

Conducted by: G. J. Hogaboam, H. W. Bockstahler.

Location: M.S.U. Farm, East Lansing, Michigan - South Nursery.

Cooperation: Michigan Agricultural Experimental Station - Farm Crops Department.

Date of Planting: May 22, 1959.

Date of Harvest: October 21, 1959.

Experimental Design: 6 x 6 Triple lattice, 6 replications.

Size of Plots: 1 row x 22 feet, 28 inches between rows.

Harvested Area per Plot for Root Yield: 1 row x 20 feet.

Samples for Sucrose Determination: All beets in row taken for one sugar sample.

Stand Counts: Harvested beets counted when weighed.

Recent Field History: Black root nursery, continuous beets since 1950.

Fertilization of Beet Crop: 1000# 5-20-20 each year since 1957.

Leafspot Exposure: Moderate.

Black Root Exposure: Moderate.

Other Diseases and Pests: A few plants showed symptoms of mosaic and savoy. Small amount of Rhizoctonia root rot in field.

Soil and Seasonal Conditions: Seedbed wet. Ample moisture throughout the season.

Reliability of Test: Good.

Cooperator: Mich. Agr. Expt. Station - Farm Crops Dept. Year: 1959

Location: East Lansing, Michigan. South Nursery. Expt.: 59-11

(Results given as 6 plot averages)

Variety and Description				Acre-Yield Gross Sugar	Acre-Yield Roots	Sucrose	Purity	Beets per 100' of row	
				Pounds	Tons	Percent	Percent	Number	
EL 1025	SL	119MS X (601aa X 558-0)	mm	3264	11.05	14.7	89.95	71	
EL 1027	SL	119MS X (601aa X 566-0)	mm	3895	13.85	14.0	87.81	76	
EL 1028	SL	119MS X 5733-0	mm	4433	14.47	15.3	89.25	85	
EL 1029	SL	119MS X 5714-0	Mm	5014	17.19	14.6	90.22	88	
EL 1024	SL	117MS X 5714-0	Mm	4437	15.48	14.3	89.98	88	
EL 1026	SL	117MS X 5716-0	Mm	3848	12.83	15.0	89.69	76	
EL 1013		5714-0 (WC 8220)	MM	4580	15.71	14.6	89.40	79	1.7310
EL 1014		5716-0 (WC 8308)	MM	4785	16.65	14.4	90.41	83	1.527
EL 1015		5733-0 (WC 8310)	mm	3708	12.83	14.5	88.83	83	1.823
		5831-0 Syn. Var.	mm	4524	15.71	14.4	89.35	87	1.716
		5834-0 Syn. Var.	mm	3960	14.55	13.5	86.45	78	2.115
		5835-0 Syn. Var.	mm	4110	13.77	14.8	88.77	84	[illegible]
		5836-0 Syn. Var.	mm	3916	14.47	13.5	88.15	84	1.815
		5840-0 Syn. Var.	mm	3501	12.68	13.9	87.83	78	1.926
		5822-0 Syn. - 7 clones	MM	4352	14.31	15.2	89.76	57	1.734
		5850-01 Bolting res. sel.	MM	4713	16.02	14.8	89.53	74	1.731
		5851-01 Bolting res. sel.	MM	4230	15.25	13.9	87.05	85	2.068
		5852-01 Broad base BR-LS res.	MM	5094	18.75	13.6	87.65	77	1.916
		58101-0 LS-CT res. from US 104	MM	4807	17.73	13.6	89.11	82	1.662
EL 1012		5713-0 (WC 8306)	MM	4036	13.46	15.0	88.60	68	1.930
EL 1016		571850-00 (WC 8309) Storage RR	MM	5074	18.36	13.8	88.26	89	1.837
Acc 1410		5460-0 (WC 6327)	MM	4787	16.80	14.2	88.50	81	1.84?
EL 1023		5481-0 (Lot 801)	MM	4849	17.03	14.3	89.40	78	[illegible]
Acc 1402		5510-0 (WC 7370)	MM	4755	16.26	14.6	87.26	69	.132?
EL 1022		US 401 (Lot 810)	MM	4771	17.11	14.0	88.32	86	1.851
EL 1017		571-0 (U-I incr.) LS-CT res.	MM	2602	8.87	14.7	87.12	66	2.173
EL 1018		57102-0 (U-I incr.) LS-CT res.	MM	4198	14.55	14.5	89.09	81	1.776
EL 1019	SL	117MS X 571-0	Mm	4390	14.31	15.3	89.96	75	
EL 1020	SL	117MS X 57102-0	Mm	4529	15.25	14.9	89.61	78	
EL 1021	SL	122 X 57102-0	Mm	3850	13.22	14.3	89.72	64	
EL 1030	SL	122 X 571-0	Mm	3780	13.38	14.1	88.55	63	
	SL	108MS X 5460-0	Mm	5536	18.59	14.9	88.94	88	
	SL	117MS X 5481-0	Mm	4417	15.40	14.3	88.73	64	
	SL	117MS X 5714-0 (Comm'l)	Mm	4491	15.87	14.1	89.60	68	
		58169-01 (mm lines X 5481-0 / 5510-0)	Mm	5139	18.05	14.3	89.20	86	
Acc 1327		Synthetic Check	MM	2818	10.36	13.6	87.42	68	1.957
General Mean				4310.8	15.00	14.37	88.818	77.4	
S.E. Variety Mean				385.38	1.294	.328	.8860	6.9	
" " "as % of Gen. Mean				8.94	8.62	2.29	1.00	8.97	
Diff. req. for sig. (Odds 19:1)				1076	3.61	.9	NS	19	

Variance Table

Random Block Analysis

Source of variation	D/F	Mean Squares: Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
Between replications	5	1,108,021	10.4709	1.16	9.2437	733.0
Between varieties	35	2,441,617	31.1707	1.61	5.9483	438.2
Remainder - Error	175	893,647	10.0508	0.65	4.7076	289.5
Total	215					
Calculated F. value		2.73**	3.10**	2.48**	1.26NS	1.51*
Req. for sig. 5% level	35/175	1.50	1.50	1.50	1.50	1.50
" " " 1% "	35/175	1.76	1.76	1.76	1.76	1.76

AGRONOMIC EVALUATION TEST - 1959

Conducted by: G. J. Hogaboam, H. W. Bockstahler.

Location: M.S.U. Farm, East Lansing, Michigan, North Nursery.

Cooperation: Michigan Agricultural Experimental Station - Farm Crops Department.

Date of Planting: May 4, 1959.

Date of Harvest: November 2, 1959.

Experimental Design: 6 x 6 Triple lattice, 6 replications.

Size of Plots: 8 rows x 22 feet, 28 inches between rows.

Harvested Area per Plot for Root Yield: 6 inner rows x 20 feet, hand topped.

Samples for Sucrose Determination: One ten-beet sample selected at random from each of the outside harvested rows.

Stand Counts: Harvested beets counted when weighed.

Recent Field History: Broadcast seeding of beets in 1956; 1957 - Red Clover 1000" 5-20-20 plowed down; 1958 - Beets - agronomic evaluation test, 1000# 5-20-20.

Fertilization of Beet Crop: Severe burning by mid-August. Infection started in replications 1 and 4 and spread North through replications 2 and 5 to replications 3 and 6.

Black Root Exposure: Slight.

Other Diseases and Pests: Beets were severely weakened by leaf spot predisposing them to infection by root rotting pathogens.

Soil and Seasonal Conditions: Seedbed moist, ample moisture throughout the season. Frequent showers during July and August favored build-up of leaf spot. Harvest period very wet.

Reliability of Test: Good. Leaf spot combined with excessive rainfall at harvest resulted in extremely low sugar and purity readings.

Cooperator: Mich. Agr. Expt. Station - Farm Crops Dept. Year: 1959

Location: East Lansing, Michigan. NOrth Nursery. Expt.: 59-13

(Results given as 6 plot averages)

Variety and Description				Acre-Yield Gross Sugar	Acre-Yield Roots	Sucrose	Purity	Beets per 100' of row	
				Pounds	Tons	Percent	Percent	Number	
EL 1025	SL	119MS X (601aa X 558-0)	mm 2	2276	12.90	8.7	85.19	93	
EL 1027	SL	119MS X (601aa X 566-0)	mm 1	2731	13.57 4	9.9 2	85.77	98	
EL 1028	SL	119MS X 5733-0	mm 3	1862	12.47	7.0	78.32	99	
EL 1029	SL	119MS X 5714-0	Mm	2214	14.09 8	7.5	83.02	97	
EL 1024	SL	117MS X 5714-0	Mm	1778	12.68	6.9	84.16	94	
EL 1026	SL	117MS X 5716-0	Mm	2106	13.95 9	7.5	81.30	91	
EL 1013		5714-0 (WC 8220)	MM	1947	12.26	7.7	80.50	88	1.865
EL 1014		5716-0 (WC 8308)	MM	1908	12.95	7.3 18	82.88 13	93	1.508
EL 1015		5733-0 (WC 8310)	mm 4	1947	11.46	8.3	79.51	89	2.139
		5831-0 Syn. Var.	mm 6	1774	11.69	7.2	80.99	90	1.690
		5834-0 Syn. Var.	mm	1573	12.63	5.9	75.44	85	1.921
		5835-0 Syn. Var.	mm 5	1807	11.53	7.4	82.18	99	1.605
		5836-0 Syn. Var.	mm	1478	11.63	5.9	76.62	90	1.800
		5840-0 Syn. Var.	mm	841	9.11	4.6	76.47	88	1.41
		5822-0 Syn. - 7 clones	MM	3083 2	13.43 16	11.4 1	87.98 1	72	1.55
		5850-01 Bolting res. sel.	MM	2146	11.68	8.5	84.35	82	1.577
		5851-01 Bolting res. sel.	MM	1859	13.55 15	6.7	81.99	92	1.471
		5852-01 Broad base BR-LS res.	MM	2796	16.00 3	8.5	82.41	85	1.814
		58101-0 LS-CT res. from US 104	MM	1741	13.59 13	6.1	78.94	91	1.627
EL 1012		5713-0 (WC 8306)	MM	2180	12.87	8.4	83.55	88	1.654
EL 1016		571850-00 (WC 8309) Storage RR	MM	3345 1	17.15 1	9.8 3	82.95	94	2.014
Acc 1410		5460-0 (WC 6327)	MM	2163	13.15	8.0	83.03	88	1.635
EL 1023		5481-0 (Lot 801)	MM	2139	14.81 4	7.1	81.33	96	1.630
Acc 1402		5510-0 (WC 7370)	MM	3019	16.61 2	8.9 4	85.02 4	92	1.568
EL 1022		US 401 (Lot 810)	MM	2369	14.30 6	8.0	83.73	91	1.555
EL 1017		571-0 (U-I incr.) LS-CT res.	MM	985	9.84	5.0	76.54	82	1.533
EL 1018		57102-0 (U-I incr.) LS-CT res.	MM	1805	12.38	6.8	78.77	80	1.833
EL 1019	SL	117MS X 571-0	Mm	1548	12.54	5.8	77.67	91	
EL 1020	SL	117MS X 57102-0	Mm	1745	13.68 11	6.0	77.95	96	
EL 1021	SL	122 X 57102-0	Mm	1989	12.82	7.4	81.35	88	
EL 1030	SL	122 X 571-0	Mm	1915	13.79 10	6.9	81.09	92	
	SL	108MS X 5460-0	Mm	2032	14.22 7	6.7	78.16	94	
	SL	117MS X 5481-0	Mm	1800	13.64 12	6.5	83.30	89	
	SL	117MS X 5714-0 (Comm'l)	Mm	1697	11.85	6.5	79.12	81	
		58169-01 (mm lines X 5481-0 / 5510-0)	Mm	2036	14.60 5	6.5	79.48	96	
Acc 1327		Synthetic Check	MM	1555	13.08	5.8	78.33	80	1.605
General Mean				2005	13.13	7.3	81.09	90	
S.E. Variety Mean				291.3	.8667	.79	1.9326	3.6	
" " " as % of Gen. Mean				14.53	6.60	10.88	2.38	4.04	
Diff. req. for sig. (Odds 19:1)				813	2.42	2.2	5.39	10	

Variance Table

Random Block Analysis

Source of variation	D/F	Mean Squares: Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
Between replications	5	10,217,960	27.2840	74.98	217.2060	318.9
Between varieties	35	1,612,470	15.5077	11.77	54.2222	217.9
Remainder - Error	175	594,070	4.5039	3.78	22.4125	78.7
Total	215					
Calculated F. value		2.71**	3.44**	3.11**	2.42**	2.77**
Req. for sig. 5% level	35/175	1.50	1.50	1.50	1.50	1.50
" " " 1% "	35/175	1.76	1.76	1.76	1.76	1.76

AGRONOMIC EVALUATION TEST, 1959

Conducted by: H. E. Brewbaker, H. L. Bush and Dave Sunderland

Location: E. S. Krauss Farm, Findlay, Ohio

Cooperator: Northern Ohio Sugar Company

Date of Planting: April 15, 1959

Date of Harvest: September 19, 1959

Experimental Design: Triple Rectangular Lattice

Size of Plots: 6 rows x 22 feet (30 inch rows)

Harvested Area per Plot for Root Yield: 6 rows x 18 feet

Samples for Sucrose Determinations: 2 samples per plot, each 1 row x 18 feet

Stand and Bolter Counts: Beets counted in laboratory for stand
No bolters developed

Recent Field History: Preceding crop - alfalfa

Leaf Spot Exposure: Severe on susceptible variety in border rows
Readings for varieties in test included in table
Development of disease started latter part of August

Black Root Exposure: Not enough to cause losses in stand

Curly Top Exposure: None noted

Other Diseases: Some root rot (probably Rhizoctonia) noted at time of harvest

Soil and Seasonal Conditions: Good growing conditions throughout the season.
High humidity conducive to leaf spot development.

Cooperator: Northern Ohio Sugar Company by H. E. Brewbaker, H. L. Bush and D. L. Sunderland

Location: Findlay, Ohio Year: 1959

(Results given as 6 plot averages)

Variety	Acre Yield Sugar Recoverable[a] (lbs.)	Acre Yield Sugar Gross (lbs.)	Acre Yield Roots (tons)	Sucrose (%)	Thin Juice App. Purity (%)	Leaf Spot[d]	Rotten Beets[e] (%)	Beets per 100 ft. (No.)	% Non-Sugar Solids
USDA SP5822-0	5424	6407	22.05	14.53	92.53	2.0	0.81	124	1.173
USDA SP5724-0	5196	6106	21.26	14.36	92.77	3.0	0.68	118	1.119
USDA SP5481-0	5119	6129	21.61	14.18	91.97	2.7	0.00	132	1.238
USDA SP5611-0	5092	6253	22.77	13.73	90.90	3.3	0.00	120	1.375
US401	5012	6004	21.77	13.79	91.95	4.8	0.40	124	1.207
USDA SP5510-0	4893	6011	21.27	14.13	90.88	3.7	0.00	121	1.418
USDA SP5714-0	4879	5865	20.58	14.25	91.77	2.0	0.00	128	1.278
USDA SP55600-01	4817	5638	20.62	13.67	93.00	4.7	0.00	124	1.029
GW674 x US401	4774	5814	21.63	~~13.44~~	~~91.27~~	4.0	2.25	111	
USDA SP571850-00	4715	6132	22.71	13.50	88.68	4.8	0.00	122	1.723
USDA SP5850-01	4551	5435	19.22	14.14	92.08	3.3	0.86	116	1.216
USDA SP5716-0	4362	5157	19.61	13.15	92.58	2.7	0.00	116	1.054
USDA SP5733-0 mm	3410	4299	15.84	13.57	89.87	4.7	0.94	106	1.530
General Mean[f]	4788	5788	20.84	13.88	91.56	3.5	0.46	120	
S.E. Variety Mean	-	158.42	.6288	.1681	.5149	-	-	-	
S.E. Variety Mean as % of Gen. Mean	-	2.70	2.42	1.20	0.56	-	-	-	
Diff. req. for Sig. (Odds 19:1)	401[b]	485	1.58	0.48	1.44	-	-	-	

Variance Table

Source of Variation	DF	Mean Squares: Gross Sugar[c] (lbs.)	Roots (tons)	Sucrose (%)	Purity (%)
Replicates	5	-	17.81	.8400	2.0480
Component (a)	12	-	3.20	.1875	.4217
Component (b)	12	-	7.84	.2192	1.2825
Blocks (eliminating varieties)	24	-	5.52	.2033	.8521
Varieties (ignoring blocks)	19	-	13.54	.7400	6.7805
Error (Intra-Block)	71	-	1.54[g]	.1694[g]	1.8401
Error (Random Block)	95	-	2.56	.1780	1.5905
Total	119	-	4.93	.2955	2.4384
Calculated F value	-	-	8.79**	4.37**	4.26**

(a, (b, (c See attached sheet (occurring as p. 258)

(d 0 = no evidence of disease, 10 = complete necrosis

(e Percentage of beets obviously rotten in field at time of harvest.

(f General mean for 20 varieties included in complete test

(g Error term used

AGRONOMIC EVALUATION TEST, 1959

Conducted by: H. E. Brewbaker, H. L. Bush, R. K. Oldemeyer and Dave Sunderland

Location: Glenn Haas Farm, Fremont, Ohio

Cooperation: Northern Ohio Sugar Company

Date of Planting: April 18, 1959

Date of Harvest: 6 replicates September 18 and 6 replicates November 10, 1959

Experimental Design: Triple Rectangular Lattice

Size of Plots: 6 rows x 22 feet planted (30 inch rows)

Harvest Area per Plot for Root Yield: 6 rows x 18 feet

Samples for Sucrose Determinations: 2 samples per plot, each 1 row x 18 feet

Stand Counts and Bolter Counts: Beets counted in laboratory for stand. No bolters developed.

Recent Field History: 1958 tomatoes

Fertilization of Beet Crop: 600 lbs. per acre of 12-12-12 plowed under
250 lbs. per acre of 3-18-9 with seed

Leaf Spot Exposure: Severe on susceptible variety in border rows, readings for varieties in test included in table. Development of disease started late August. Readings for both September and November harvests made September 17, but readings for November harvest area are slightly higher.

Black Root Exposure: Not enough to cause stand losses.

Curly Top Exposure: None noted

Other Diseases: Some root rot (probably Rhizoctonia) noted at time of harvest.

Soil and Seasonal Conditions: Good growing conditions throughout the season with high humidity conducive to leaf spot development even though soil was dry during September. Heavy rains during normal harvest period contributed to 5.13 tons per acre increase in general mean for November harvest over September harvest.

Cooperator: Northern Ohio Sugar Company by H. E. Brewbaker, H. L. Bush and D. L. Sunderland

Location: Glen Haas Farm, Fremont, Ohio   Year: 1959, September Harvest

(Results given as 6 plot averages)

Variety	Acre Yield: Sugar: Recoverable[a] (lbs.)	Acre Yield: Sugar: Gross (lbs.)	Acre Yield: Roots (tons)	Sucrose (%)	Rank	Thin Juice App. Purity (%)	Rank	Leaf Spot[d]	Rotten Beets[e]	Rank	Beets per 100 ft. (No.)	% Sugar
USDA SP5822-0	5326 1	6338	20.63 3	15.36	4	92.15	1	1.0	0.56	1	143	1.308
USDA SP5724-0	5299	6459	21.08 1	15.32	6	91.13	3	2.0	0.67	4	149	1.491
USDA SP55600-01	5122	6293	20.30	15.50	2	90.80	6	3.3	0.67	1	149	1.570
USDA SP5510-0	5108	6437	21.01 2	15.32	6	89.78	11	3.0	0.23	12	143	1.744
USDA SP5481-0	5058	6234	20.40	15.28	7	90.67	7	1.8	0.19	7	154	1.572
GW674 x US401	4905	6151	20.18	15.24	8	90.00	9	3.0	0.21	10	140	1.693
US401	4889	6131	20.52	14.94	10	90.00	9	3.7	1.33	9	150	1.660
USDA SP5714-0	4773	5716	18.39	15.54	1	91.88	2	1.0	0.22	2	149	1.373
USDA SP5611-0	4618	5744	19.30	14.88	12	90.32	8	3.3	0.55	8	146	1.595
USDA SP571850-00	4572	5780	19.28	14.99	9	89.68	12	4.0	0.00	11	147	1.725
USDA SP5716-0	4567	5605	19.05	14.71	13	90.87	5	2.0	0.56	3	143	1.478
USDA SP5850-01	4191	5122	16.64	15.39	3	91.02	4	2.0	0.35	5	139	1.512
USDA SP5733-0 mm	3622	4616	15.47	14.92	11	89.37	13	4.2	1.43	13	140	1.775
General Mean[f]	4773	5894	19.40	15.18		90.59		2.6	0.54		146	
S.E. Variety Mean	-	214.87	.6778	.1650		.4267		-	-		-	
S.E. Variety Mean as % of Gen. Mean	-	3.58	3.41	1.09		0.47		-	-		-	
Diff. req. for Sig. (Odds 19:1)	502[b]	621	1.95	0.49		1.20		-	-		-	

Variance Table

Source of Variation	DF	Mean Squares: Gross Sugar[c] (lbs.)	Roots (tons)	Sucrose (%)	Purity (%)
Replicates	5	-	21.62	2.4660	6.0880
Component (a)	12	-	2.19	.1617	.6133
Component (b)	12	-	4.63	.4092	1.4958
Blocks (eliminating varieties)	24	-	3.39	.2854	1.0546
Varieties (ignoring blocks)	19	-	13.40	.4332	2.8994
Error (Intra-block)	71	-	2.76[g]	.1632[g]	1.1038
Error (Random Block)	95	-	2.92	.1941	1.0914[g]
Total	119	-	5.38	.3277	1.5900
Calculated F Value	-	-	4.88**	2.65**	2.66**

(a, (b, (c See attached sheet (occurring as p. 258)
(d 0 = no evidence of disease, 10 = complete necrosis
(e Percentage of beets obviously rotten in field at time of harvest
(f General mean for 20 varieties included in complete test
(g Error term used

Cooperator: Northern Ohio Sugar Company by H. E. Brewbaker, H. L. Bush, R. K. Oldemeyer and D. L. Sunderland

Location: Glen Haas Farm, Fremont, Ohio Year: 1959, November Harvest

(Results given as 6 plot averages)

Variety	Acre Yield Sugar Recoverable[a] (lbs.)	Acre Yield Sugar Gross (lbs.)	Acre Yield Roots (tons)	Sucrose (%)	Thin Juice App. Purity (%)	Leaf Spot[d]	Rotten Beets[e] (%)	Beets per 100 ft. (No.)	% Non-Sugar Solids
USDA SP5822-0	6846	8138	25.56	15.92	92.17	2.2	1.06	131	1.352
USDA SP5724-0	6488	7936	25.47	15.58	90.98	2.8	0.00	140	1.545
GW674 x US401	6460	7961	26.75	14.88	90.70	3.8	1.00	138	1.526
USDA SP5481-0	6338	7734	24.52	15.77	91.05	2.7	0.47	138	1.550
USDA SP5714-0	6275	7573	23.52	16.10	91.52	1.7	0.00	137	1.492
US401	6199	7890	26.60	14.83	89.42	3.8	0.00	142	1.755
USDA SP55600-01	6166	7697	25.57	15.05	90.18	4.2	1.55	140	1.639
USDA SP5510-0	6067	7782	25.35	15.35	89.10	3.0	1.20	139	1.878
USDA SP5611-0	6038	7490	24.72	15.15	90.43	3.3	1.65	129	1.570
USDA SP5716-0	6010	7371	24.57	15.00	90.90	2.2	0.48	136	1.502
USDA SP571850-00	5973	7703	25.97	14.83	88.92	5.0	0.68	136	1.865
USDA SP5850-01	5749	7086	22.61	15.67	90.67	2.7	0.00	128	1.612
USDA SP5733-0 mm	4513	5815	19.32	15.05	88.95	3.7	0.00	137	1.870
General Mean[f]	6086	7552	24.66	15.32	90.36	3.2	0.62	136	
S.E. Variety Mean	-	210.51	.6084	.1931	.4190	-	-	-	
S.E. Variety Mean as % of Gen. Mean	-	2.75	2.44	1.26	0.47	-	-	-	
Diff. req. for Sig. (Odds 19:1)	491[b]	611	1.78	0.54	1.18	-	-	-	

Variance Table

Source of Variation	DF	Mean Squares: Gross Sugar[c] (lbs.)	Roots (tons)	Sucrose (%)	Purity (%)
Replicates	5	-	12.67	.8660	4.0560
Component (a)	12	-	2.96	.2083	.9892
Component (b)	12	-	3.35	.2425	.9183
Blocks (eliminating varieties)	24	-	3.17	.2254	.9538
Varieties (ignoring blocks)	19	-	16.97	.9721	4.7295
Error (Intra-Block)	71	-	2.22[g]	.2230	1.0197
Error (Random Block)	95	-	2.46	.2236[g]	1.0031[g]
Total	119	-	5.20	.3701	1.7263
Calculated F Value	-	-	7.64**	4.35**	4.71**

(a, (b, (c See attached sheet (occurring as p. 258)
(d 0 = no evidence of disease, 10 = complete necrosis
(e Percentage of beets obviously rotten in field at time of harvest
(f General mean for 20 varieties included in complete test
(g Error term used

(a <u>Recoverable Sugar</u>

A technique, whereby thin juice purity could be determined from small samples was first used in 1953, following methods recently developed in the G. W. Research Laboratory at Denver. Using the resultant purity figure, a calculated "Recoverable Sugar" is obtained. An example of the calculation is as follows:

Sugar in beets = 12.00%
Standard total losses = 0.30%
Sugar on beets at sugar end = 12.00 - 0.30 = 11.70%

Assume standard molasses purity = 62.5%
100.0 - 62.5 = 37.5% Impurities on solids in molasses

$\frac{62.5}{37.5}$ = 1.6667% Sugar on impurities in molasses

Sugar sacked
85% purity thin juice = 15% impurities

$\frac{15}{85}$ = 17.6471% impurities on sugar

Sugar end = 11.70 x 17.6471% = 2.06471% on beets
Molasses produced = 2.06471 x 1.66667 = 3.4413% on beets
Sugar sacked = 12.00 - (0.30 + 3.4413) = 8.2587%

Recoverable sugar = $\frac{8.2587}{12.00}$ = 68.82%

(b <u>Approximation</u> - Calculated as percentage of "difference required for significance for "gross" sugar on basis of relationship between general means for "Gross" and "Recoverable" sugar.

(c <u>Calculated from the formula:</u>

$$\text{S lbs. sugar} = \sqrt{\left(\frac{\text{S lbs. beets}}{\text{Mean lbs. beets}}\right)^2 + \left(\frac{\text{S \% sugar}}{\text{Mean \% sugar}}\right)^2}$$

(See pages 254, 256, 257, 260, and 261 for application of (a, (b, and (c.)

CTR-LSR AGRONOMIC EVALUATION TEST, 1959

Conducted by: H. E. Brewbaker and H. L. Bush

Location: Great Western Sugar Company, Experiment Station Farm, Longmont, Colo.

Cooperation: Great Western Sugar Company

Date of Planting: April 6, 1959

Date of Harvest: October 22, 1959

Experimental Design: Randomized Complete Block

Size of Plots: 6 rows x 24 feet planted (22 inch rows)

Harvested Area per Plot for Root Yield: 6 rows x 18 feet

Samples for Sucrose Determinations: 2 samples per plot, each 1 row x 18 feet

Stand and Bolter Counts: Beets counted in laboratory for stand
No bolters developed in this test

Recent Field History: Small grain 1957, Corn 1958

Fertilization of Beet Crop: 150 lbs. per acre ammonium nitrate and
150 lbs. per acre treble superphosphate plowed under

Leaf Spot Exposure: No leaf spot developed

Black Root Exposure: None noted

Curly Top Exposure: None observed

Other Diseases: None observed

Soil and Seasonal Conditions: Field in good state of fertility with ample moisture (high water table).
Very wet when harvested.

Cooperator: Great Western Sugar Company by H. E. Brewbaker and H. L. Bush

Location: Great Western Sugar Company, Experiment Station Farm, Longmont, Colo.

Year: 1959

(Results given as 6 plot averages)

Variety	Acre Yield: Recoverable Sugar[a] (lbs.)	Acre Yield: Gross Sugar (lbs.)	Acre Yield: Roots (tons)	Sucrose (%)	Thin Juice App. Purity (%)	Beets per 100 ft. (No.)
GW674-57AD	8114	8743	24.56	17.80	96.78	107
SL91 MS x GW674	7766	8392	23.84	17.60	96.67	108
SP58101-0	7187	7791	24.12	16.15	96.60	111
SP571-0	6845	7277	20.91	17.40	97.55	106
SP57102-0	6245	6735	21.49	15.67	96.90	107
Mean[d]	7540	8129	23.84	17.05	96.82	107
Sm	-	175.18	.4737	.1397	.2223	-
Sm/Gen. M. (%)	-	2.16	1.99	0.82	0.23	-
LSD 5% pt.	463[b]	499	1.35	0.40	0.63	-

Variance Table

Source of Variation	DF	Mean Squares: Gross Sugar[c] (lbs.)	Mean Squares: Roots (tons)	Mean Squares: Sucrose (%)	Mean Squares: Purity (%)
Replicates	5	-	1.00	.0720	1.8880
Varieties	9	-	14.67	2.6911	.4811
Error	45	-	1.35	.1171	.2964
Total	59	-	3.35	.5059	.4595
Calculated F Value	-	-	10.87**	22.98**	NS

(a, (b, (c See attached sheet (occurring as p. 258)

(d Mean for 10 varieties in complete test

Cooperator: Great Western Sugar Company by H. E. Brewbaker, R. R. Wood and H. L. Bush

Location: Alec Bangert Farm, Billings, Montana　　　　Year: 1959

(Results given as 6 plot averages)

Variety	Acre Yield: Recoverable Sugar[a] (lbs.)	Acre Yield: Gross Sugar (lbs.)	Acre Yield: Roots (tons)	Sucrose (%)	Thin Juice App. Purity (%)	Bolters (%)	Beets per 100 ft. (No.)
Klein E	6904	8035	25.77	15.59	93.65	0.00	141
SLC20 mm Klein E	5873	6818	21.95	15.53	93.26	1.04	124
Mean[d]	6265	7199	22.97	15.67	93.73	1.36	128
Sm	-	187.07[c]	.5188	.2015	.4810	-	-
Sm/Gen. M. (%)	-	2.60	2.26	1.29	0.51	-	-
LSD 5% pt.	473[b]	543	1.52	0.58	1.38	-	-

(a, (b, (c　See attached sheet (occurring as p. 258)

(d　Mean for 36 varieties in complete test

AGRONOMIC VARIETAL EVALUATION TEST, 1959

Leoti, Kansas

(Results given as 6-plot averages)

Variety	Acre Yield		Sucrose
	Gross sucrose	Roots	
	Lbs.	Tons	%
Com'l. issue, National Blend	6730 1	21.2 1	16.0 3
Utah-Idaho E-114 monogerm	6110 4	18.4 4	16.6 2
Polybeet	6610 2	19.2 3	17.3 1
US 22/4	6570 3	21.0 2	15.8 5
SP 57109-0	5810 5	18.4 4	15.8 5
SP 58100-04	5520 6	17.4 6	15.9 4
LSD 5%	NS	2.6	NS

The test was conducted on the Dick Elder farm near Leoti, Kansas, by the Tribune Branch Station of Kansas Agricultural Experiment Station (T. B. Stinson and R. E. Gwin, Jr.) and the National Sugar Manufacturing Company. A 6 x 6 Latin Square design was used. Plots were 6 rows x 40 feet (rows 22 inches apart); 4 rows x 10 feet in each plot harvested for record. Two tare samples were taken from each plot at harvest, and both were analyzed for sucrose percentage. Summarization and statistical analyses of results were performed by R. E. Gwin, Jr.

Thinning was done with long handled hoe, only. Stand counts were not made, but it was observed that yield in only 3 plots was affected to a moderate degree by poor stand (1 plot, each, of US 22/4, SP 57109-0, and SP 58100-04). There was no evidence of damage to any of the varieties by leaf spot or curly top.

Rocky Ford, Colorado "B" Test - 1959

Conducted By: American Crystal Research Staff.

Location: Guthrie Unit of Research Station, Rocky Ford, Colorado.

Date Planted: April 16, 1959.

Date of Harvest: October 10, 1959.

Experimental Design: 10 x 8 Randomized Block.

Size of Plots: 4 rows x 35 feet, 22 inch rows.

Harvested Area per Plot for Root Yield: 2 inner rows, 35 feet, hand topped.

Samples for Sucrose Determinations: Two 20-beet samples taken at random:

Stand Count: Harvested beets counted when weighed.

Recent Field History: 1958 - Grain, Sweet Clover
1957 - Alfalfa
1956 - Alfalfa

Fertilization of Beet Crop: 400 pounds of 13-39-0.

Diseases and Pests: Not a factor.

Soil and Seasonal Conditions: Soil very variable -
Beets were dry several times because irrigation ditches were dry. Severe hail on September 24th stripped off all the leaves.

Reliability of Test: Fair.

Rocky Ford, Colorado "B" Test - 1959

Description	Variety	Acre - Yield: Gross Sugar Pounds	Acre - Yield: Roots Tons	Sucrose Percent	Beets Per 100' of Row Number
Sedlmayr's Variety	Maribo P-A1	6212	22.69	13.69	121.1
Commercial	American #2	5853	19.84	14.75	165.1
(610 x 91) x 108) x 117 MS x SP 571-0	SLC #117 MS x SP 571-0	5150	19.84	12.98	139.1
Sedlmayr's Variety	Maribo A-5	5105	19.22	13.28	156.6
Sedlmayr's Variety	Maribo P-A3	5090	20.71	12.29	124.6
Sedlmayr's Variety	Maribo P-A10	4607	17.09	13.48	153.1
(610 x 91) x 108) x 122 MS x SP 57102-0	SLC #122 MS x SP 57102-0	4392	17.64	12.45	152.1
USDA - CTR-LSR	SP 571-0	4219	16.09	13.11	137.3
(610 x 91) x 108) x 117 MS x SP 57102-0	SLC #117 MS x SP 57102-0	4216	16.81	12.54	136.3
USDA - CTR-LSR	SP 57102-0	4035	16.55	12.19	146.8
General Mean		4875	18.65	13.07	143.3
S. E. Variety Mean		220.8	0.63	0.39	5.63
" " " as % of Gen. Mean		4.53%	3.38%	3.01%	3.93%
Diff. Req. for Sig. (Odds 19:1)		624	1.78	1.11	1.59

Variance Table

Source of Variation	D/F	Mean Squares: Gross Sugar a/ Pounds	Mean Squares: Roots (Tons)	Mean Squares: Sucrose Percent	Mean Squares: Beets Per 100' Row
Blocks	7	--	4692.17	6.744	82.71
Varieties	9	--	1279.95	4.870	779.44
Error	63	--	110.30	1.241	124.41
Total	79				
Calculated F. Value		--	11.60**	3.92**	6.26**

a/ Calculated from the formula:

$$\text{SE lbs. Sugar} = \text{Mean lbs. Sugar} \sqrt{\left(\frac{\text{SE lbs. Beets}}{\text{Mean lbs. Beets}}\right)^2 + \left(\frac{\text{SE \% Sugar}}{\text{Mean \% Sugar}}\right)^2}$$

** Significant at the 1% level

Texas Preliminary Variety Test - 1959

Conducted by: American Crystal Sugar Company Research Staff.

Location: E. C. Reindover Ranch, Hereford, Texas.

Date of Planting: April 17, 1959.

Date of Harvest: December 2, 1959.

Experimental Design: 8 x 8 Latin Square.

Size of Plots: 4 rows, 35 feet long, 30 inch rows.

Harvested Area Per Plot for Root Yield: 2 center rows 35 feet long, hand topped.

Samples for Sucrose Determinations: Two 10-beet samples per plot, taken at random.

Stand Count: Harvested beets counted when weighed

Recent Field History: 1958 -
1957 - Beets
1956 - Potatoes

Diseases: Severe leaf-spot. Slight curly-top. Rhizoctonia crown rot scattered through out the field.

Soil and Seasonal Conditions: Good

Reliability of Test: Good

Texas Preliminary Variety Test - 1959

Description	Variety	Acre - Yield: Gross Sugar Pounds	Acre - Yield: Roots Tons	Sucrose Percent	Beets Per 100' of Row Number
(610 x 91) x 108) x 122 MS x SP 571-0	SLC #122 MS x SP 571-0	9631	34.43	13.99	134.3
" " x 117 MS x SP 571-0	SLC #117 MS x SP 571-0	8988	32.85	13.68	138.9
" " x 117 MS x Low Gal. Sel.	SLC #117 MS x 56-407-0	8549	30.49	14.02	178.3
" " x 117 MS x SP 57102-0	SLC #117 MS x SP 57102-0	8535	30.57	13.96	164.4
" " x 122 MS x SP 57102-0	SLC #122 MS x SP 57102-0	8352	30.64	13.63	164.4
CTR-LSR	SP 571-0	8181	31.06	13.17	124.6
CTR-LSR	SP 57102-0	8075	29.82	13.54	173.6
Commercial	US #35	7513	27.60	13.61	184.3
General Mean		8475	30.93	13.70	157.8
S. E. Variety Mean		279.0	.82	.27	5.31
" " " as % of General Mean		3.29%	2.65%	1.95%	3.37%
Diff. Req. for Sig. (Odds 19:1)		796	2.34	.76	15.1

Variance Table

Source of Variation	D/F	Mean Squares: Gross Sugar a/ Pounds	Roots Tons	Sucrose Percent	Beets Per 100' Row
Columns	7	-	741.88	1.444	412.57
Blocks	7	-	1119.95	3.834	346.14
Varieties	7	-	2108.56	1,313	1940.00
Error	42	-	348.24	.573	110.64
Total	63				
Calculated F. Value		-	6.05**	2.29*	17.53**

a/ Calculated from the formula:

$$\text{SE lbs. Sugar} = \text{Mean lbs. Sugar} \sqrt{\left(\frac{\text{SE lbs. Beets}}{\text{Mean lbs. Beets}}\right)^2 + \left(\frac{\text{SE \% Sugar}}{\text{Mean \% Sugar}}\right)^2}$$

**Significant at the 1% point.

East Grand Forks General Variety Test - 1959

Conducted By: D. B. Ogden.

Location: Company Farm - East Grand Forks, Minnesota.

Date of Planting: April 14, 1959.

Date of Harvest: September 19, 1959.

Experimental Design: 8 x 8 Latin Square.

Size of Plots: 3 rows x 35 feet long, 22 inch rows.

Harvest Area per Plot for Root Yield: 3 rows 35 feet long.

Samples for Sucrose Determination: All beets in one row divided into two sugar samples.

Stand Count: Harvested beets counted when weighed.

Recent Field History: 1958 - Sweet Clover - Summer Fallow
1957 - Grain
1956 - Beets

Fertilizers: Approximately 200 pounds of 0-42-0 plowed down with Sweet Clover.

Diseases: Some leaf-spot - late.

Seasonal Conditions: Dry in August and wet in September at harvest time.

Reliability of Test: Good.

East Grand Forks, Minnesota General Variety Test - 1959

Description	Variety	Acre - Yield Gross Sugar Pounds	Acre - Yield Roots Tons	Sucrose Percent	Beets Per 100' of Row Number
Commercial	Am #3 N	6399	20.33	15.74	92.5
Am #3 S Monogerm Backcrossed (MC-120;171;173)	58-608	5545	17.01	16.30	88.4
SLC #3 x American #3	58-305	5500	16.77	16.40	91.4
American #3 S Monogerm (Waseca)	58-602	5226	16.56	15.78	80.4
American #3 S Monogerm (Blue Earth)	58-603	5212	15.94	16.35	86.2
Am #3 S Monogerm (SLC #15 x 56-601)	58-809	5047	15.52	16.26	83.6
USDA Monogerm	5834-0	4909	16.30	15.06	87.2
USDA Monogerm	5836-0	4527	15.14	14.95	81.7
General Mean		5294	16.70	15.85	86.4
S. E. Variety Mean		151.4	0.43	.19	2.17
" " " as % of General Mean		2.86%	2.58%	1.23%	2.51%
Diff. Req. for Sig. (Odds 19:1)		432	1.23	.56	6.2

Variance Table

Source of Variation	D/F	Mean Squares: Gross Sugar a/ Pounds	Roots (Tons)	Sucrose Percent	Beets Per 100' Row
Columns	7	--	146.86	.4900	219.29
Blocks	7	--	228.05	2.6757	25.42
Varieties	7	--	1596.09	2.7128	168.71
Error	42	--	116.32	.3050	41.48
Total	63				
Calculated F. Value		--	13.72**	8.89**	4.07**

a/ Calculated from the formula:

$$\text{SE lbs. Sugar} = \text{Mean lbs. Sugar} \sqrt{\left(\frac{\text{SE lbs. Beets}}{\text{Mean lbs. Beets}}\right)^2 + \left(\frac{\text{SE \% Sugar}}{\text{Mean \% Sugar}}\right)^2}$$

**Significant at the 1% point.

AGRONOMIC EVALUATION TEST OF EUROPEAN INTRODUCTIONS IN COMPARISON WITH CERTAIN U.S. VARIETIES, 1959

Fort Collins, Colorado Experiment No. 2A

Conducted by: J. O. Gaskill and J. A. Elder.

Location: Hospital Farm, Fort Collins, Colorado; Field no. 4; under sprinkler.

Cooperation: Colorado Agricultural Experiment Station and Board of County Commissioners of Larimer County.

Dates of Planting and Harvest: May 12; October 22.

Experimental Design: Randomized block, 6 replications.

Size of Plots: One row x 24'; rows 20" apart.

Harvested Area per Plot for Root Yield: An accurately measured length of row with satisfactory stand (in the row and adjacent to it) was harvested in each plot -- averaging approximately 18 ft. per plot. All harvested roots were topped, washed, and weighed.

Samples for Sucrose Determinations: Pulp from all roots harvested in any given plot was composited. Duplicate sucrose determinations were made, with a third determination in case the first 2 failed to agree satisfactorily.

Stand and Bolter Counts: Stand for each plot was based on roots taken from the harvested section of that plot (see above). There were no bolters in this experiment.

Recent Field History: Crops: 1955, sugar beets; 1956-57, alfalfa; 1958, wheat. Fertilization for 1959 sugar beet crop: treble superphosphate (approximately 280 pounds per acre) and ammonium nitrate (approximately 220 pounds per acre). Shell DD was applied in the fall of 1958 for nematode control.

Leaf Spot Exposure: Very severe.

Black Root and Curly Top Exposure: Negligible.

Other Diseases and Pests: Sugar beet nematode was present but effects were considered negligible.

Seasonal and other Conditions: The weather was not far from normal except for considerable snowfall late in September and during parts of October. There were no severe freezes before harvest. Furrow irrigation was adequate. Parathion and Toxaphene were used (1 application) for insect control. The field was inoculated with a spore suspension of Cercospora beticola on July 13, using a 4-row power sprayer. Periodic light sprinkling with water was employed as an additional aid in developing the leaf spot disease.

Reliability of Test: Stand and uniformity of soil, moisture, and disease exposure were satisfactory. The results are considered reliable, subject to the reservation that border effects in 1-row-plot tests, such as this, may tend somewhat to exaggerate differences between varieties, particularly in yield.

EXPERIMENT NO. 2A - 1959, FORT COLLINS, COLORADO (UNDER SPRINKLER)
(Results given as 6-plot averages)

Description	Seed No.	Foliage Notes a/ Leaf Spot	Foliage Notes a/ Size	Stand (Beets per 100')	Harvest Results Root Yield per Acre	Harvest Results Sucrose	Harvest Results Gross Sucrose per Acre
				No.	Tons	%	Lbs.
Russian monogerm var.; Elite seed; P.I. 254575	Acc.2198	5.2	5.0	127	12.79	11.46	2936
" " " ; 1st reprod. P.I. 254576	" 2199	4.5	5.2	123	12.42	11.63	2906
LS-BR mm syn. var.; SP 5832-0	" 2197	3.1	5.2	129	9.76	12.38	2420
Self-ster., mm, LS-BR-stor. rot res. sel.	591101-0	3.1	6.0	130	12.52	12.97	3253
Hilleshog (Sweden); H 3611 Tetra	Acc.2201	4.5	4.7	117	12.53	12.38	3101
" " ; H 3609 4n D	" 2202	4.4	4.5	120	10.91	12.18	2658
" " ; E 7685 4n I	" 2203	5.2	3.8	119	8.53	12.56	2140
" " ; H 19 4n J	" 2204	4.8	4.5	121	10.67	12.53	2680
" " ; H 3790 4n Z	" 2205	4.8	4.8	125	10.52	12.33	2597
" " ; H 5828 4n DP	" 2206	4.3	5.0	122	11.35	13.91	3165
" " ; H 3958 4n UP	" 2207	3.2	6.0	118	12.73	12.44	3167
High sucrose (Poland); AJ_1 (Janasz)	" 2208	5.3	5.0	114	10.32	14.54	3000
" " " ; 2A (Udycz)	" 2209	5.8	4.5	121	9.32	15.40	2860
Cercos. leaf spot res., (Poland); CLR (2n)	" 2210	4.3	6.0	122	13.52	14.72	3982 1
Polyploid Cerc. L.S. res., (Poland); CLR (Poly.)	" 2211	4.4	5.2	120	13.50	14.43	3893 2
US 401; WC 5354	" 2057	3.3	5.8	123	12.38	12.95	3225 4
SP 5481-0; WC 5214	" 2191	3.0	6.0	126	12.84	12.91	3322 3
General Mean					11.5644	13.0404	3017.75
S. E. of Variety Mean					0.4935	0.2399	149.00
S. E. of Variety Mean as % of General Mean					4.27	1.84	4.94
Calculated F value					9.42**	22.67**	9.93**
L. S. D. at 5% point					1.39	0.68	419

a/ Foliage Notes (8/31/59): Leaf Spot: 0 = no leaf spot; 10 = complete defoliation. Size: low no. = small; high no. = large.

** F equal to or greater than 1% point.

MISCELLANEOUS VARIETY TEST - East Lansing, Michigan, 1959

Reported by J. G. Hogaboam

Seed Designation	Entry No.	Average Plot Weight (lbs.)				Average % Sucrose	
		6 repl.	5 repl.	4 repl.	2 repl.	3 repl.	2 repl.
Tetra (H 3611)	1101	31.5	31.4	31.3	31.5	8.2	8.3
4N D (H 3609)	1102	26.0	25.6	23.8	26.5	9.2	9.7
4N I (E 7685)	1103	24.5	24.4	25.8	27.0	9.9	10.0
4N J (H 19)	1104	33.7	33.2	32.0	34.0	8.5	8.9
4N Z (H 3790)	1105	28.0	27.4	27.2	24.5	8.5	8.0
4N DP (H 5828)	1106	--	29.2	29.0	23.5	9.0	8.5
4N UP (H 3958)	1107	29.0	29.0	30.3	37.5	9.5	9.5
Klein E	1108	35.3	35.0	33.5	34.5	9.2	9.0
Udycz (2 A)	1109	23.3	23.4	22.0	18.5	13.0	13.8
CLR 2N	1110	30.7	31.2	33.5	34.0	12.2	12.5
CLR Poly	1111	33.3	32.8	32.3	32.0	12.7	12.0
US 401	1112	26.5	27.0	25.8	23.0	10.3	10.0
PI 254575 USSR mm	1113	--	--	32.0	31.5	8.1	8.0
PI 254576 USSR mm	1114	--	33.2	36.8	41.0	9.6	10.3
Janasz (AJ_1)	1115	--	--	--	26.5	--	13.9
SP 5481-0	1116	32.0	31.0	29.5	36.0	9.0	9.2
LSD .05		5.9	N.S.	8.1	10.3	2.1	3.0

Comment: A severe epidemic of leaf spot developed about a month before harvest. The extent of leaf damage is reflected in low sucrose percentages. Disease readings on US 401 and SP 5481-0 were approximately 5; on 4N DP, 4N UP, CLR Poly and PI 254576, about 7.5; and on the remainder of the entries, about 8 or 9.

SUGAR BEET VARIETY TESTS

conducted by Lauren Burtch, Spreckels Sugar Co.

Location: Yuba City, California
Grower: Tsujia Inouye
Varieties: 16 (6 reported)
Replications: 6

Planted: April 10, 1959
Harvested: November 4, 1959
Plot size: 1 row 30" x 60'

Variety	Sugar Tons/Ac.	Roots Tons/Ac.	Sucrose %	Harvest Stand/100' row
US 400	4.45 1	27.83	15.96	137
SP 5716-0	3.99 2	24.93	15.96	147
SP 5714-0	3.92	24.54	16.00 2	138
SP 5713-0	3.54	22.82	15.53	150
US 56/2	3.09	19.24	16.08 1	130
General mean	3.87	24.14	16.01	140
LSD P = .05	0.91	N.S.	0.47	
LSD P = .01	N.S.	N.S.	N.S.	

Location: Woodland, California
Grower: Delatorres Bros.
Varieties: 8 (2 reported)
Replications: 8

Planted: March 18, 1959
Harvested: September 21, 1959
Plot size: 1-40" bed
(2 rows 14x26") x 60'

Variety	Sugar Tons/Ac.	Roots Tons/Ac.	Sucrose %	Harvest Stand/100' row
US 56/2	2.64	22.12	11.98	207
SP 5716-0	2.46	23.25	10.66	193
General Mean	2.90	25.16	11.56	213
LSD P = .05	0.24	2.19	0.52	
LSD P = .01	0.36	2.92	0.70	

PART XI

PRELIMINARY EXPERIMENTS WITH RUSSIAN MONOGERM SUGAR BEETS

Introduction

- -

Preliminary Field Trials

- -

Preliminary Breeding Studies

Dewey Stewart
G. E. Coe
J. O. Gaskill
G. J. Hogaboam
F. V. Owen
A. M. Murphy
G. K. Ryser
C. H. Smith

RUSSIAN MONOGERM SUGAR BEETS[1]

During the past few years, the Russian literature has indicated rapid progress in the Soviet Union on the development of monogerm varieties of sugar beets. Probably one can take a statement in a brochure given out in 1959 at the Soviet Exhibition of Science in New York City as an optimistic summary of the literature: "The plant breeders O. K. Kolomeitz (Belaya Tserkov experimental centre) and A. V. Popov (Yaltushkovo plant breeding station) have evolved new monogerm varieties, Belotserkovoskaya and the Yaltushkovskaya. This year, monogerm varieties will be sown on 741,000 acres." Although the indicated acreage in monogerm varieties looms large, it is only about 12 percent of the total sugar-beet acreage in the Soviet Union.

Monogerm varieties of sugar beets which were developed to meet requirements in the U.S.S.R. probably would not be suitable for this country, especially in districts where diseases are major hazards. Nevertheless, it was thought desirable to acquire seed of Russian varieties and explore the potential value of this source of germ plasm in the improvement of American monogerm varieties. Since all American monogerm breeding material stems from a single plant found in 1948, a source of unrelated germ plasm could be of great value in the production of monogerm hybrids.

In Sugar Beet Research, 1958, Page 5, mention was made of two monogerm sugar-beet introductions (PI 254575 and PI 254576) from the All-Union Institute of Plant Industry, Leningrad, U.S.S.R. Accession PI 254575 is elite seed from Belaya Tserkov (White Church) Station, and Accession PI 254576 is from Yaltushkov Station. A few grams of each accession were supplied to all sugar-beet breeding centers in this country, and slightly larger quantities were furnished to four major stations of the Sugar Beet Section for preliminary field evaluations.

A short time before the two introductions were received from the All-Union Institute of Plant Industry, approximately 100 monogerm seeds (PI 263121) were made available (without varietal designation) to a member of a U. S. Agricultural Survey Team visiting in U.S.S.R. This seed was planted at Beltsville and at Salt Lake City.

Preliminary field tests with PI 254575 and PI 254576 are summarized on page 275; individual tests are reported on pages 270 (Gaskill), 271 (Hogaboam) and 276 (Ryser and Smith). In addition, a planting of the two accessions was made by A. M. Murphy at Jerome, Idaho, and by G. E. Coe at Beltsville, Md. In the Jerome test, the Russian monogerm varieties were extremely susceptible to curly top; in the Beltsville test, the varieties suffered severe damage from leaf spot. The latter test confirms the reports by Gaskill and Hogaboam.

Preliminary results on breeding, by Owen and Ryser (277), indicate that monogermness in American and in Russian varieties of sugar beets is not conditioned by the same genic components, which will have a definite bearing on future breeding and on the ultimate utilization of the Russian monogerm character in this country.

[1] Discussion by Dewey Stewart

RUSSIAN MONOGERM SUGAR BEETS

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PRELIMINARY FIELD TESTS WITH RUSSIAN MONOGERM INTRODUCTIONS

Location	Reported by[1/]	PI 254575	PI 254576	Klein E	US 401	Monogerm SP 5832-0	LSD Odds 19:1
ROOT YIELD							
Taylorsville, Utah	Ryser & Smith	35.0[2/]	34.2[2/]	40.2[2/]	--		N.S.
Fort Collins, Colo.	Gaskill	12.8[2/]	12.4[2/]	--	12.4[2/]	9.8[2/]	1.4[2/]
East Lansing, Mich.	Hogaboam	31.5[3/]	41.0[3/]	34.5[3/]	23.0[3/]	--	10.3[3/]
SUCROSE PERCENTAGE							
Taylorsville, Utah	Ryser & Smith	11.6	13.4	14.2	--	--	0.45
Fort Collins, Colo.	Gaskill	11.5	11.6	--	13.0	12.4	0.68
East Lansing, Mich.	Hogaboam	8.0	10.3	9.0	10.0	--	2.1

1/ Test by Smith and Ryser given on Page 276; by Gaskill, on Page 270; by Hogaboam, on Page 271.
2/ Calc. Tons/Acre
3/ Pounds per plot

VARIETY TEST, TAYLORSVILLE, UTAH, 1959
Including two Russian monogerm introductions

By G. K. Ryser and
C. H. Smith

S.L. Inventory No.	DESCRIPTION	ACRE YIELD GROSS SUGAR POUNDS	ACRE YIELD TONS BEETS	SUGAR PERCENT
4324	Klein E	11,378	40.2	14.2
8333	White Church, monogerm PI 254575	8,382	35.0	11.6
8334	Yaltushka, monogerm PI 254576	9,227	34.2	13.4
General MEAN of all varieties		9,666	36.5	13.2
S. E. of MEAN		546	2.50	0.06
Sig. Diff. (19:1)		NS	NS	0.35
S. E. of MEAN in % of MEAN				0.45

Planted, April 2, 1959 Harvested October 5, 1959

Diseases: Mild curly-top exposure

Experimental design: 3 X 3 Latin square
Plots: One row each 22 feet long with 4 foot alleys
The whole row of each plot taken for two sucrose analyses

PRELIMINARY HYBRIDS WITH NEW RUSSIAN MONOGERM BEETS

By F. V. Owen and George K. Ryser

Three Russian monogerm introductions were received at Salt Lake City from our Beltsville office. Twenty-five seeds of PI 263121 seed lot were received October 17, 1958. A few grams of seed originating from two different breeding stations, White Church (PI 254575) and Yaltushka (PI 254576), were received December 24, 1958. Seed was planted in the greenhouse. Only seven plants were obtained from PI 263121 lot and these were grown entirely in the greenhouse. Plants from the White Church origin were transplanted to the field after thermal induction in the cold frame. The populations grown from both of these Russian seed lots showed evidence of multigerm segregation. The following tabulation gives the rough classifications:

Seed lot	Individual plants classified for multiplicity of flower clusters				
	Monogerm*				
	No doubles	2% or less doubles	2 to 5% doubles	Multigerm	Total plants
PI 263121	0	5	--	2	7
White Church PI 254575	2	13	40	25	80

* Assumed to be monogerm with some allowance for double-germ seed balls.

The more or less continuous variation from plant to plant made classification difficult. Therefore, the difference between what one might consider monogerm and multigerm was not always clearly defined. Plants classified as multigerm had some triple-germ flower clusters.

F_1 Hybrids

For production of F_1 hybrids a monogerm annual Mendelian male-sterile clone (74536-9 BB mm aa) derived from SLC 101 was selected for female parentage. This annual monogerm clone had been used extensively as a tester for Mm versus MM genotypes. The pollinators consisted of monogerm plants grown from PI 263121 and White Church seed lots. The F_1 progenies were not strictly monogerm, although there was a reduced number of flowers per flower cluster. For classification work five different classes were established as follows:

A. All flowers single, no doubles
B. Mostly singles but a few doubles on central axis
C. Some singles, many doubles and doubles on side branches
D. Some singles plus doubles and triples
E. Some quadruple clusters, or all doubles and triples

In addition to the above classification a record was made of ten flower clusters at the base of the main stem of each F_1 plant. Seven progenies from crosses to the annual clone were classified as follows:

Population	Total plants	Multiplicity of flower clusters (single plant classifications)					
		Class					Av. of ten at base of main stem
		A	B	C	D	E	
	Number	%	%	%	%	%	Number
94447	10	0	0	30	60	10	2.17
94448	17	0	0	0	88	12	2.51
94449	28	0	11	46	28	14	2.09
94451	16	0	0	69	31	0	1.94
94453	40	0	3	52	37	7	1.99
94454*	12	0	33	25	42	0	1.99
94682*	16	0	50	44	6	0	1.93

* Monogerm pollinators from the White Church origin were used for production of the F_1 hybrids 94454 and 94682. All others were from PI 263121 origin.

Backcross Populations, White Church X PI 263121 F_1 Hybrid

Utilizing F_1 plants from populations 94448 and 94449 as pollinators, two crosses were made to the White Church self-sterile monogerm plant No. 50. Plant No. 50 was also the pollinator responsible for the F_1 population 94682 shown in the tabulation on the previous page. The b_1 populations were grown in a warm greenhouse under continuous illumination and the following results were obtained:

Population	Total flowering plants	Multiplicity of flower clusters (single plant classifications)					
		Class:					Av. of ten at base of main stem
		A	B	C	D	E	
	Number	%	%	%	%	%	Number
94683	17	6	35	24	35	0	1.78
94684	16	18	69	13	0	0	1.46

In both populations there was clear-cut segregation for annual Bb and vegetative or biennial bb segregates. There were 12 vegetative segregates in population 94683 and 17 in population 94684. These were placed under thermal induction so they may be classified at a later date. It is of interest to observe that in the two backcross populations the multiplicity of the flower clusters was reduced as compared with the F_1 populations and that some pure monogerm (class A) segregates appeared. Inflorescences of selected monogerm segregates were placed under paper bags. By means of these paper bags pollinations were made to the Mendelian male-sterile clone 74536-9 BB mm [redacted] for a continuation of the investigations.

PART XII

BREEDING MONOGERM SUGAR BEETS SUITABLE FOR MICHIGAN AND THE EASTERN AREAS

H. L. Kohls

Assistant Professor in Farm Crops, Michigan State University

PROGRESS REPORT ON BREEDING MONOGERM VARIETIES SUITABLE TO THE EASTERN SUGAR BEET AREA

by H. L. Kohls

The most important need in the eastern sugar beet area, from a breeding standpoint, is a monogerm variety with a relatively high sugar content when grown under adverse fall conditions. It must, of course, be equal to or better than our present commercial variety when grown under favorable conditions.

We now have on hand several strains suitable for commercial use, from the standpoint of yield and resistance to disease, but they are multigerm and have low sugar content when preharvest conditions are not favorable for good sugar production. We have, however, noticed that some strains tend to maintain a relatively high sugar content under the same unfavorable conditions. It is highly desirable that this tendency be developed further and that it and the monogerm character be added to a good commercial variety.

To develop a monogerm variety that would maintain a relatively high sugar content under a wide range of conditions, a number of carefully selected roots were put into a crossing program, and from this we now have emerging several promising strains. Most of these trace back to a very few of the original selections.

One group of closely related strains carrying monogerm came from 6 selections. Most of these strains have good tonnage and fair sugar percentage. Another group also carrying monogerm came from two multigerm hybridizations--one involving US 401 and the other, a related strain. The monogerm strains have had two or three cycles of selections at Beltsville. These strains are similar to the first group in size of root and percent sugar, but the two groups are unrelated. Evidence thus far indicates that the strains of the unrelated groups cross well, the hybrids being high yielding with sugar content equal to US 401.

1/ Assistant Professor in Farm Crops, Michigan State University, East Lansing, Mich.

[illegible] OF [illegible] TO THE [illegible]

SUGAR BEET [illegible]

by R. L. [illegible]

The most important need in the eastern sugar beet areas, from a breeding stand-point, is a monogerm variety with a relatively high sugar content when grown under adverse fall conditions. It must, of course, be equal to or better than our present commercial variety when grown under favorable conditions.

[illegible] have no such combined strains suitable for commercial use, from the stand-point of yield and resistance to disease, but have [illegible] have low sugar content when growing conditions are not favorable for good sugar production. We have, however, noticed that some strains tend to maintain a relatively high sugar content under the more unfavorable conditions. It is highly desirable that this [illegible] may be developed further and that it [illegible] in the monogerm [illegible] be added to a good commercial variety.

To develop a monogerm variety [illegible] we would [illegible] a relatively high sugar content under a wide range of conditions, a number of carefully selected roots were put into a breeding program, and from this we now have [illegible] several promising lines. Most of these trace back to a very few of the original selections.

One group of closely related strains carrying monogerm came from 3 selections. Most of these strains have good tonnage and fair sugar percentage. Another group [illegible] carrying monogerm came from the multigerm hybridizations—one involving US 400 and the other a related strain. The monogerm strains have had two or three cycles of selection at Beltsville. Most strains are similar to the first group in size of root and percent sugar, but the two groups are unrelated. Evidence thus far [illegible] that the [illegible] groups [illegible] hybrids [illegible]

[illegible] sugar content [illegible] large [illegible] sugar content

---

[illegible], Michigan [illegible] Mich.

Another group of 4 or 5 strains trace back to a cross between two plants. Most of the roots of these strains are of good shape and are very smooth and free of sprangles. The roots lack size but have fair sugar content. These strains are of particular interest as breeding stock to improve shape and smoothness of roots in other breeding material. See figures 1, 2, 3, 4, and 5.

58EL-57 came from 2 selections out of US 401 and is characterized by having good weight and fair sugar content. 57C1M-15, one of the selections in this strain, has been used several times [redacted] parent in crosses and most of its hybrid progeny are high yielding beets with fair sugar percentage. We have a few selected roots from this strain that appear very good. They averaged 9.8 pounds in weight per root with 12.8 percent sugar, while US 401 averaged 8.1 pounds with 12.0 percent sugar.

One of our most promising strains is entry number 84 of 1959, which is a cross between two half sibs. The common parent is clone 02 which is a selection out of strain SP 53AB1-32. The two other parents are monogerm selections out of J751-1 and J753-2 made at East Lansing. Under adverse conditions, just previous to harvest at East Lansing, selected roots of entry 84 averaged 5.4 pounds with 12.6 percent sugar. In the same test, roots of US 401 averaged 4.7 pounds with 8.5 percent sugar. This promising strain also showed considerable resistance to leaf spot. The roots, however, were badly forked; but this may not be a serious problem when grown in close spacing, [redacted] in commercial fields. This strain may be useful as [redacted] pollinator on a good male-sterile monogerm in the production of [redacted] commercial hybrid.

57EL-42 is of interest to us because of its resistance to leaf spot. In both 1958 and 1959, disease readings at Beltsville were "3" for 57EL-42 and "5" for US 401, in the [redacted] tests. 57EL-42 is a "closely" bred strain from our Acc. 345 variety and is being crossed with [redacted] male-sterile monogerm for the production of a hybrid monogerm variety.

group of 4 or 5 stands broke back to a great between the plants. Most of the ote of these strains are of good shape and are very smooth. Free

The roots lack also but have fat sugar content. These strains are of interest as breeding stock to improve shape and smoothness of roots in breeding material. See Figures 1, 2, 3, 4, and 5.

RA-57 came from 8 selections out of US 401 and is characterized by having good sugar content. 57035-85, one of the selections in this strain, has been used several times as a parent in crosses and most of its hybrid progeny are high yielding beets with fair sugar percentages. We have a few selected roots from ... ratio ... appear very good. They averaged 7.8 pounds in weight per root with ... sugar, while US 401 averaged 6.2 pounds with 12.0 percent sugar.

... of our ... crosses ... tle is entry number 24 of 1955. ... is a cross ... two half sibs. The common parent is clone 62 which is a selection out of ... 5145-12. The two other parents are monogerm selections out of 4751-1 and ... at East Lansing. Under adverse conditions, just previous to harvest at ... Lansing, selected roots of entry 24 averaged 5.4 pounds with 12.6 percent sugar. ... beet ... of US 401 averaged 4.7 pounds with 8.5 percent sugar. This strain also showed considerable resistance to leaf spot. The roots, however, ... ly ... but this may not be a serious problem when grown in close spacing. Fields. This strain may be useful as a pollinator and good male ... in the production of a commercial hybrid.

... because of its ... to leaf spot. ... both ... readings at ... were "4" for 5718-12 and "5" for US 401. 5718-12 ... loosely" bred strain ... variety and ... a male-st... monogerm ... the production of a hybrid monogerm

Fig. 1. Entry No. 33 Smooth well shaped roots are typical of this closely bred strain. Weight per root is 7 to 7 1/2 lb.

Fig. 2. Entry No. 51. These coarse rough roots are among the best that could be selected from this strain. These roots weigh 10 to 12 lbs. each.

Fig. 3. Entry No. 10. These roots represent a cross between a smooth type and a coarse type and show the smoothness of the smooth parent. The beet 3rd from the left weighs 12.6 lbs and has 15.5 percent sugar.

Fig. 4. Roots of 57EL-42 grown at East Lansing, Michigan in wide spacing and little competition between plants are ill shaped. Compare with Fig. 5.

Fig. 5. Roots of 57EL-42 grown at Beltsville, Maryland in close spacing are smooth and free of much of the roughness of the same variety grown at East Lansing. See Fig 4.

14.00 3.80 %

14.00 2.50

11.00 2.4 %